



FINAL REPORT

FOUNDATIONS FOR GROWTH:

AN ECONOMIC ANALYSIS OF THE LIFE SCIENCES IN MISSOURI

PREPARED FOR:

The State of Missouri
The University of Missouri System
The Danforth Foundation
The Ewing Marion Kauffman Foundation

PREPARED BY:

Technology Partnership Practice
Battelle Memorial Institute
Cleveland, Ohio

December 2001

Battelle Memorial Institute (Battelle) does not endorse or recommend particular companies, products, services, or technologies, nor does it endorse or recommend financial investments and/or the purchase or sale of securities. Battelle makes no warranty or guarantee, express or implied, including without limitation, warranties of fitness for a particular purpose or merchantability, for any report, service, data, or other information provided herein.

Copyright 2001 Battelle Memorial Institute. Use, duplication, or distribution of this document or any part thereof is prohibited without the written permission of Battelle Memorial Institute. Unauthorized use may violate the copyright laws and result in civil and/or criminal penalties.

FOUNDATIONS FOR GROWTH: AN ECONOMIC ANALYSIS OF THE LIFE SCIENCES IN MISSOURI

Prepared for:

THE STATE OF MISSOURI
THE UNIVERSITY OF MISSOURI SYSTEM
THE DANFORTH FOUNDATION
THE EWING MARION KAUFFMAN FOUNDATION

Prepared by:

TECHNOLOGY PARTNERSHIP PRACTICE
BATTELLE MEMORIAL INSTITUTE

December 2001

CONTENTS

Executive Summary	vi
Introduction	vi
Profile of the Missouri Life Science Sector	vi
Composition and Specializations within the Life Science Sector ...	vii
Spatial and Metropolitan Distributions	viii
Establishment-Level Characteristics	ix
Conclusion	ix
Introduction	1
Definitions	1
Data and Methodology	5
Profile of the Missouri Life Science Sector	7
Composition and Specializations within the Life Science Sector	10
Life Science Subsectors—United States	10
Life Science Subsectors—Missouri	12
Detailed Industry Strength Classification	18
Spatial and Metropolitan Distributions	22
Life Science Sector	22
Life Science Subsectors	27
Establishment-Level Characteristics	37
Conclusions	41
Appendix	42

TABLES AND FIGURES

Tables

1. Life Sciences Sectoral Definition, by SIC	3
2. Summary Data, Life Science Sector (1995 and 2001)	7
3. Subsector-Level Data (1995 and 2001)	11
B1. Missouri Bioinformatics Establishments	14
B2. Missouri Environmental Life Science Establishments	17
4. Detailed Industry Strengths	19
5. Life Science Distribution by Metropolitan Area, Missouri (2001)	26
6. Life Science Establishment Characteristics, Missouri (2001)	38
A1. Missouri Metropolitan Areas by County	42
A2. Data for Detailed Life Science Industries, Missouri (1995 and 2001).....	43
A3. Data for Detailed Life Science Industries, St. Louis (1995 and 2001).....	44
A4. Data for Detailed Life Science Industries, Kansas City (1995 and 2001).....	45
A5. Data for Detailed Life Science Industries, Missouri, excluding St. Louis and Kansas City (1995 and 2001).....	46

Figures

ES1. Life Science Subsectors, Missouri (2001)	vii
1. Missouri Metropolitan Areas	4
2. Location Quotients	8
3. Establishments and Employment by Subsector, Missouri (2001) (identical to Figure ES1)	13
4. Missouri Life Science Subsectors	16
5. Key Missouri Life Science Strengths	18
6. Spatial Distribution of Life Science Establishments, Missouri	23
7. Spatial Distribution of Life Science Establishments, St. Louis	24
8. Spatial Distribution of Life Science Establishments, Kansas City	25
9. Missouri Life Science Distribution by Metropolitan Area	26

Figures, continued

- 10. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, Missouri 28**
- 11. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, St. Louis 29**
- 12. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, Kansas City 30**
- 13. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, Missouri 31**
- 14. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, St. Louis 32**
- 15. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, Kansas City 33**
- 16. Youthful Life Science Establishments and Employment in Missouri, Benchmark States, and the United States (2001) 39**
- 17. Youthful Research & Testing Establishments and Employment in Missouri, Benchmark States, and the United States (2001) 40**

Foundations for Growth: An Economic Analysis of the Life Sciences in Missouri

EXECUTIVE SUMMARY

Introduction

The life sciences, as one of the most dynamic and growth-oriented sectors of the economy, present tremendous opportunities for economic development. Unusual in its inherent diversity, the life science sector combines expertise from biology, agriculture, public health, organic chemistry, medical sciences, engineering, and computer science, among other fields. The life sciences are positioned at the very forefront of creativity and innovation. New arenas of research and application are arising, from bioinformatics to proteomics and combinatorial biology. Simultaneous progress in microelectronics, robotics, and nanotechnology is establishing new avenues for advancements in medical devices, surgical practices, and drug delivery.

The economic analysis of the Missouri life sciences portrays a picture of an industry sector nearing a fundamental junction between two possible futures. Missouri possesses strengths in clinical biomedical and agricultural life science fields. Yet, declining employment in the non-clinical biomedical life sciences and only modest growth in high-technology life science research and testing do not bode well for regional innovation and progress. The actions and efforts undertaken during the next decade likely will be decisive in determining Missouri's future position in the life sciences.

For this economic analysis, the term "life sciences" is used to refer to a relatively broad range of biological and life-science-related activity: food and nutrition, organic and agricultural chemicals, drugs and pharmaceuticals, medical devices and instruments, hospitals and laboratories, and life science research and testing. The establishment and employment data used throughout the analysis are from the *MarketPlace* survey conducted by the Dun & Bradstreet Corporation. Additional information was obtained from local stakeholders, previous studies, confidential Missouri ES-202 data files, OneSource's CorpTech database, and corporate and industry Web sites.

Profile of the Missouri Life Science Sector

The life science sector is already of considerable size in Missouri and is continuing to expand in establishments and employment. Missouri's life science sector consists of 1,815 establishments and greater than 193,000 life science workers, an addition of more than 19,000 jobs since 1995. Missouri is 14 percent more concentrated in the life sciences than the entire United States: one of every 21 workers nationwide and one of every 18 workers in Missouri is employed in the life sciences. Life science establishment growth has been stronger in metropolitan St. Louis and Kansas City than elsewhere in

Missouri, whereas areas outside of these two major metropolitan areas have accounted for most of the employment expansion of the past six years.

Composition and Specializations within the Life Science Sector

For the most part, Missouri's life science strengths tend to be in the subsectors that are less technology-intensive (food and nutrition) or present less potential for generating and sustaining technology-based growth and development (hospitals and laboratories).

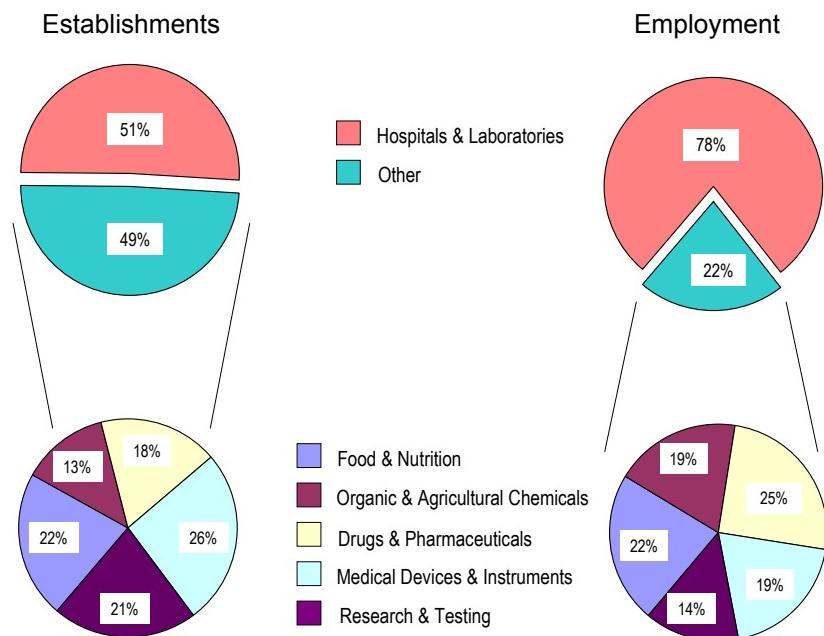
Hospitals and laboratories dominate the Missouri life science sector to a greater extent than nationwide, accounting for 51 percent of life science establishments and 78 percent of life science employment in the region. Employment in the hospitals and laboratories subsector has grown by 17.5 percent between 1995 and 2001, far outpacing the national subsector, and seemingly is driven by positive local conditions. The location quotient has climbed to 1.20, signifying a specialization of the Missouri economy.¹

The hospitals and laboratories subsector is large enough that it tends to mask the performance of the remainder of the Missouri life science sector. When hospitals and laboratories are excluded, Missouri's life science sector has performed far worse than the nation, with employment actually declining by 7.6 percent since 1995. This drop is due to substantial employment cutbacks in the biomedical manufacturing subsectors. Most of the reductions have been in the drugs and pharmaceuticals subsector, which has lost more

Missouri Life Science Profile (2001)

- 1,815 establishments
- 193,117 employees
- 11.0% employment growth, '95-'01
- 34.8% establishment increase, '95-'01
- Location quotient 1.14
- 5.5% of private sector employment

Figure ES1. Life Science Subsectors, Missouri (2001)



¹ For an explanation of location quotients, see Figure 2 in the report.

than 4,200 jobs over the past six years despite a large increase in the number of establishments in the subsector. Some, but not all, of the decline is explained by mergers and consolidations among major chemical and pharmaceutical companies in St. Louis and Kansas City. Reclassifications may also have affected the figures, as some employment labeled as within the drugs and pharmaceuticals subsector in 1995 may be classified within the medical devices and instruments subsector in 2001. Nevertheless, medical devices and instruments, a biomedical manufacturing subsector that is relatively small in Missouri, suffered a 7.4 percent decrease in employment as well, making it clear that overall employment has declined significantly. These employment declines contrast with nationwide growth rates of 39.0 percent in drugs and pharmaceuticals and 13.1 percent in medical devices and instruments over the same period.

Food and nutrition and organic and agricultural chemicals represent mainstays of the Missouri life science sector. Each subsector employs approximately 8,000 or 9,000 workers and is more concentrated in Missouri than nationwide. Despite stable employment numbers at both the national and regional levels, food and nutrition is nearly twice as concentrated in Missouri as across the United States. Organic and agricultural chemicals employment has increased by only 1.3 percent since 1995, yet has achieved a location quotient of 1.11.

Typically, the most dynamic of the six life science subsectors, research and testing evidences frequent company creation in Missouri, growing from 114 to 189 establishments between 1995 and 2001, while employment rose by 27.4 percent. Nevertheless, Missouri lags the nation in the rates of both new establishment formation and employment increase. Currently, Missouri has less than 60 percent of the national level of concentration in research and testing. By failing to keep pace with national growth rates, the region is falling further behind the nation in this important subsector that contains many emerging biotechnology firms and much innovative life science activity.

Spatial and Metropolitan Distributions

The spatial pattern of life science establishments and employment is important in examining the role of the life sciences within the larger regional economy and in identifying clusters of life science activity. The majority of life science establishments and employment are located within metropolitan St. Louis and Kansas City, in proportion to the two metropolitan areas' share of Missouri's population. In contrast, the hospitals and laboratories and food and nutrition subsectors are well dispersed among the smaller metropolitan areas and the rural portions of Missouri, reflecting the importance of discrete catchment areas for non-urban hospital establishments and the agricultural and pastoral nature of the food and nutrition industries.

The remaining four life science subsectors—organic and agricultural chemicals, drugs and pharmaceuticals, medical devices and instruments, and research and testing—are largely contained within the St. Louis and Kansas City metropolitan regions, where firms are better able to attract and retain scientists, engineers, and executive talent, and also are proximate to academic and governmental life-science-related research. Nevertheless, beyond some grouping of research and testing establishments around university campuses and other research institutes, most of the major life science employers in metropolitan St. Louis and Kansas City are spread through selected middle-ring suburban areas with

convenient access to highway routes. This absence of close spatial clustering is not surprising, given the relative size and maturity of many of Missouri's life science manufacturing entities; yet, it may make targeting support services or engaging in collaborative efforts to support the life sciences in Missouri more difficult.

Establishment-Level Characteristics

More than two-thirds of Missouri's life science establishments are either headquarters or individual sites, exercising primary control over state-level or regional operations. These establishments employ 70 percent of the life science workers in Missouri. At the same time, approximately 28 percent of the life science establishments in Missouri are five or fewer years old, a figure comparable to benchmark states as well as the United States as a whole. As would be expected, these newer establishments represent a smaller share of employment than do the more established firms, accounting for approximately 20 percent of the life science workforce.

More than 30 percent of research and testing establishments in Missouri are five years old or less; but, they employ less than 11 percent of the subsector's workforce, a fraction only half the national level. In addition, 67 percent of the employment in the subsector is contained within branch sites, the type of establishment that exerts the least local control. Together, these figures are a cause of some concern, indicating an active entrepreneurial presence, along with significant turnover and "churn," within the Missouri research and testing subsector that has had relatively little success in generating new employment at the local and regional level.

Conclusion

This economic analysis paints the overall picture of the Missouri life science sector as substantial in size, but skewed away from the most technology-intensive and innovative life science fields. Incorporating both strong foundations and severe shortcomings, the impending course of development and the degree of success to be achieved in the life sciences in Missouri will depend upon the choices made and actions taken today and in the near future.

INTRODUCTION

During the past 15 years, the life sciences have developed into one of the most widely publicized, high-growth, and high-profit sectors of the American and world economies. The life sciences are not only crucial in the furthering of human knowledge and ability, but are also present immense potential to sustain diverse economic opportunities. Even in the current environment of ongoing and largely unpredictable conflict, the life sciences are receiving renewed attention, both with regard to biological warfare and bioterrorism and as a primary strength maintaining the economic health of the United States and the rest of the developed world.

The life science sector is inherently diverse, juxtaposing and combining a wide variety of occupations and expertise, including, among others, biology, pharmacology, agricultural and animal sciences, organic chemistry, medicine, and computer science. The United States is a world leader in many areas of life science endeavor—researching, designing, and producing life science technologies and applications in fields as widespread as agricultural and food commodities, medical devices and laboratory instrumentation, drugs, and surgical procedures.

Moreover, as the life sciences inexorably expand across the United States and the world, the sector is continually developing and refining itself. An impressive assortment of terms has arisen (biotechnology, plant and life sciences, biosciences, genomics, proteomics, molecular biology, agritechnology, bioengineering, biochemical, biophysics, medical engineering, bioinformatics, bioecology, etc.) that refer to different portions of the set of biological and life-science-related activities distributed throughout the national and international economies. In addition, numerous firms within more traditional business support and service sectors have specialized to serve the needs of life science industries.

The life sciences have acted as a convergent economic force, linking and fusing local competencies and strengths through vertical integration as well as functional migration of various types of enterprises toward life-science-related activity. As a sector in which interactions between researchers and practitioners, and among an array of different industries, are vital to continued advancement, the life sciences have tended to concentrate in certain areas of the nation, particularly in the major urbanized regions along the Atlantic and Pacific seaboards. Nevertheless, other areas do support centers of life science activity and frequently are actively engaged in efforts to promulgate, support, and enhance this most promising field of endeavor.

By building upon its historical strengths as well as recently enhanced interest and investments, Missouri has the opportunity to develop into a prominent life science center. It is clear that the life sciences will play a vital economic development role in the state and region in the years and decades to come. This economic analysis explores the current position and contributions of the life science sector to the Missouri economy, as well as prospects for future expansion and development.

Definitions

Efforts to categorize the life sciences are often hampered by the unusual breadth and convergence of the field, as well as the rapid pace of redefinition as the life science

industries continue to diversify and develop. Thus, for the purposes of this analysis, the term “life sciences” is used to refer to a relatively broad swath of biological and life-science-related activity. Six subsectors are identified as key components of life science economic activity:

- Food and nutrition
- Organic and agricultural chemicals
- Drugs and pharmaceuticals
- Medical devices and instruments
- Hospitals and laboratories
- Life science research and testing.²

Each of the six subsectors is in turn composed of detailed industry segments identified at the four-, six-, or eight-digit Standard Industrial Classification (SIC) level (see Table 1).^{3,4} The first two subsectors are composed of agricultural manufacturing industries; the middle two are biomedical manufacturing industries; and the latter two are classified as services subsectors, with hospitals and laboratories also being labeled as clinical biomedical industries. Certain eight-digit industry segments within the life

² Together, these subsectors cover the majority of life science activity in Missouri as well as the United States. Nevertheless, despite the breadth of the definition, there remain enclaves of economic pursuit related to the life sciences that are not included. In part, this reflects the inadequacy of the current Industrial classification scheme to categorize life science activity; but, it is also symptomatic of the convergence precipitated by the diversity and spread of the life science sector. The North American Industry Classification System (NAICS), which has begun to replace the Standard Industrial Classification (SIC) system, does not repair this shortcoming, partly because of the inherent diversity of life sciences but also because the NAICS was devised prior to the worldwide explosion of interest and activity in the life sciences.

The definition used in this analysis was developed to facilitate the examination of the particular characteristics and inherent peculiarities of the Missouri life science sector. The industry selection rationales of previous studies were considered and incorporated where appropriate, e.g., J. M. Houghton and Associates, *Life Sciences in Missouri: Directory of Life Sciences-Related Companies, Organizations, and Institutes in Missouri*, 2000; various publications of the Missouri Department of Economic Development; Feser, Edward, “Kentucky Clusters: Industrial Interdependence and Economic Competitiveness,” 2001; Battelle, “Building Pittsburgh’s Bioscience Base,” 2001 (not yet released); and Battelle, “Economic Foundations: An Analysis of the Georgia Bioscience Sector,” 2001 (not yet released). Other regions or studies may construct differing definitions of the life sciences that are appropriate for describing and examining relevant local conditions or particular industry characteristics of interest.

³ It should also be noted that the proportion of industry activity that is truly germane to the life sciences will differ among the subsectors, as well as between geographic regions. Since there is no way to categorize activity or employment within individual establishments, total employment and establishment figures serve as a proxy measure of life science activity.

⁴ Selected individual establishments within Missouri that are classified outside the definition but have been identified as within the life sciences through previous reports or local sources have been included on an *ad hoc* basis, despite the fact that similar inclusions are not possible across the United States. Although these additions are small in comparison to the rest of the subsectors, it should be noted that, as a result, location quotients and other comparative measures may be slightly augmented in Missouri’s favor. Appendix Tables A2 through A5 give detailed figures on added establishments.

science research and testing subsector are only partially included.⁵ In addition, environmental life science, contained within these six subsectors, and bioinformatics, not covered in the quantitative portions of the analysis, are discussed separately in “Composition and Specializations within the Life Science Sector.”

Table 1. Life Sciences Sectoral Definition, by SIC

	SIC	SIC	
Food and Nutrition		Medical Device and Instrument Manufacturing*	
Creamery butter	2021	Pharmaceutical machinery	3559-9922
Cheese, natural and processed	2022	Laboratory apparatus and furniture	3821
Dry, condensed, and evaporated dairy products	2023	Analytical instruments	3826
Ice cream and frozen desserts	2024	Surgical and medical instruments	3841
Fluid milk	2026	Surgical appliances and supplies	3842
Prepared feeds, not elsewhere classified	2048	X-ray apparatus and tubes	3844
Cottonseed oil mills	2074	Electromedical equipment	3845
Soybean oil mills	2075		
Vegetable oil mills, not elsewhere classified	2076	Hospitals and Laboratories*	
Animal and marine fats and oils	2077	General medical and surgical hospitals	8062
Edible fats and oils	2079	Specialty hospitals, except psychiatric	8069
		Medical laboratories	8071
Organic and Agricultural Chemicals*		Life Science Research and Testing*	
Organic fibers, noncellulosic	2824	Commercial physical research, not elsewhere classified [†]	8731-0000
Toilet preparations	2844	Biological research	8731-01
Industrial organic chemicals, not elsewhere classified	2869	Commercial research laboratories [†]	8731-0202
Agricultural chemicals, non-fertilizer	2879	Commercial medical research	8731-9902
Drugs and Pharmaceuticals		Commercial non-laboratory research services [†]	8732-0108
Medicinals and botanicals	2833	Noncommercial biological research organizations	8733-01
Pharmaceutical preparations	2834	Noncommercial research institutes [†]	8733-9902
Diagnostic substances	2835	Scientific research agencies [†]	8733-9904
Biological products except diagnostic	2836	Testing laboratories [†]	8734-0000
		Food testing services	8734-9903
		Seed testing laboratories	8734-9908
		Veterinary testing	8734-9910

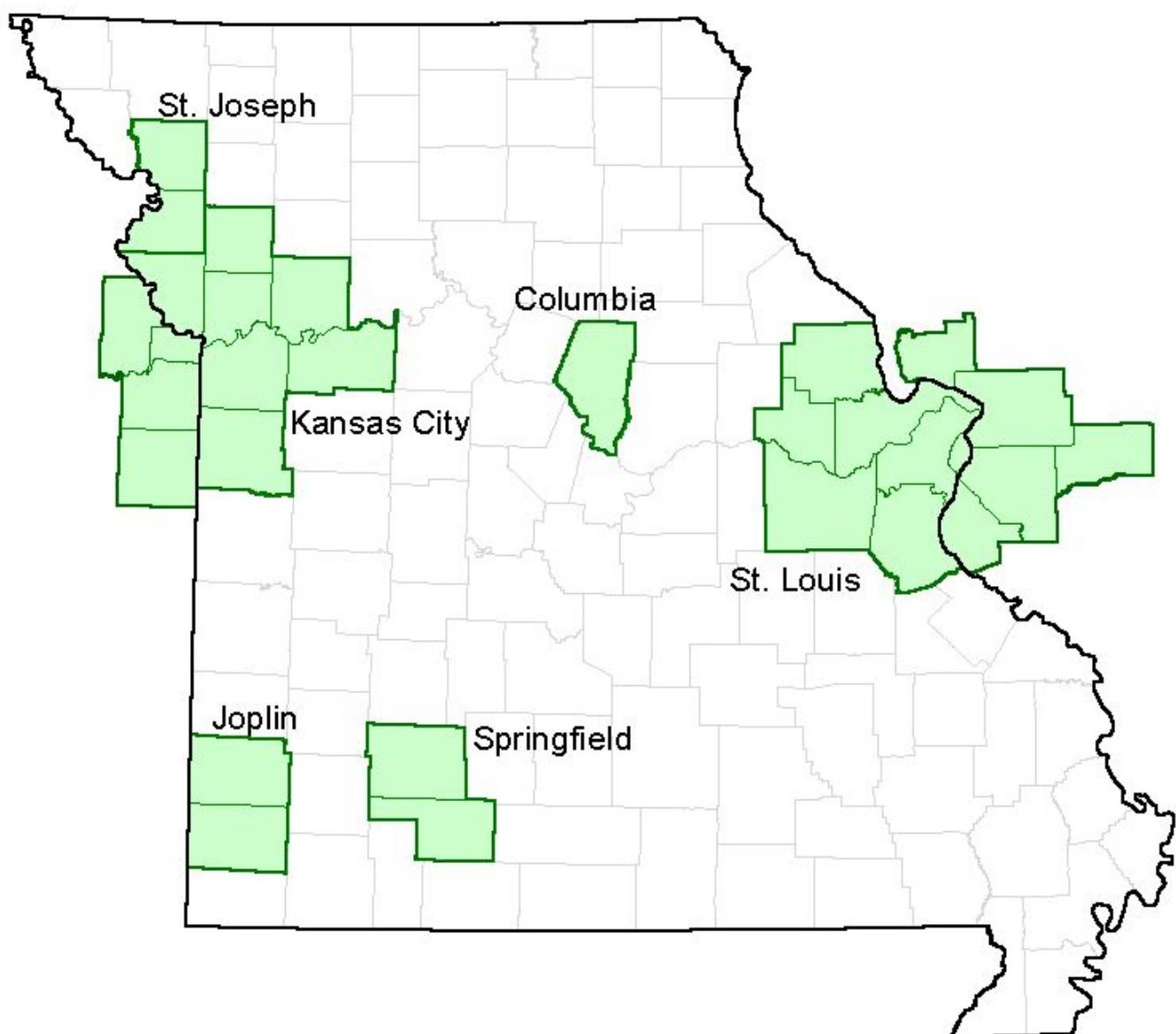
* NOTE: Certain additional Missouri establishments in unlisted SIC categories were selected for inclusion based on information from local sources. Beyond accounting for the inclusion of these additional Missouri establishments, similarly classified establishments are not added for the United States because of the lack of comparable local knowledge and input. Two establishments from 5191 (farm products wholesale) are added to Organic and Agricultural Chemicals, one from 2822 (synthetic rubber) and one from 3089-9913 (plastics and ID cards) are added to Medical Device and Instrument Manufacturing, one from 7363-9905 (medical help services) is added to Hospitals and Laboratories, and two establishments from 8732-0000 (commercial nonphysical research) and one establishment from 8734-0203 (product testing laboratories) are added to Life Science Research and Testing.

† NOTE: These SIC categories are only partially included in the analysis, with life science establishments selected within Missouri based on industry and local information. United States figures for these SIC categories are estimated by applying the ratio of life-science-to-non-life-science calculated for Missouri - see footnote 5.

⁵ These eight-digit SIC categories contain significant numbers of life science establishments, yet are not wholly composed of life science or life-science-related endeavors. Within Missouri, local information sources were used to divide the categories into life science and non-life-science portions, with only the former included in this analysis. To develop comparisons at the national level in the absence of similarly reliable establishment-level information, the life-science-to-non-life-science establishment and employment ratios calculated for Missouri were applied to the same SIC segments at the national level. This admittedly introduces bias into comparisons of Missouri with the United States, since Missouri's distribution of life science establishments and employment within the particular SIC classification is assumed to hold for the rest of the nation. In effect, this procedure serves to push comparisons toward the middle ground: if the industry segment is atypically concentrated in the life sciences in Missouri, then the comparison figures developed for the United States will be overestimated; if the industry segment is unusually sparse in the life sciences in Missouri, then the comparison figures for the United States will be underestimated. Thus, location quotients and other comparative measures should be understood to be less accurate within the research and testing subsector than within the other five life science subsectors.

Throughout this analysis, the State of Missouri typically is considered together with the out-of-state portions of the St. Louis and Kansas City metropolitan regions; the amalgamated region is referred to simply as “Missouri.” When referenced specifically as the “State of Missouri,” the region refers to Missouri proper, excluding the Illinois and Kansas portions of St. Louis and Kansas City, respectively. Both Missouri and the State of Missouri are compared with the United States as a whole. In addition, the six metropolitan areas located within Missouri are discussed as units of analysis in certain sections; each of these Metropolitan Statistical Areas (MSAs) is defined at the county level by the United States Census Bureau (see Figure 1 and Appendix Table A1).

Figure 1. Missouri Metropolitan Areas



Methodological detail concerning analytical techniques is provided throughout the analysis, and detailed data tables are located in the Appendix. By evaluating the life science industry with regard to the performance and potential of the Missouri economy, and by identifying strengths and weaknesses at both the aggregate and industry-specific levels of detail, this economic analysis forms a basis for subsequent economic and policy strategies that will elevate the future of the life sciences throughout Missouri.

Data and Methodology

This economic analysis uses establishment and employment data obtained from the *MarketPlace* survey, released on a quarterly basis by the Dun & Bradstreet Corporation, augmented with information from previous studies, local stakeholders, confidential Missouri ES-202 data files, OneSource's CorpTech database, and corporate and industry Web sites.⁶ Establishment-level data were obtained for the fourth quarter of 1995 and the third quarter of 2001.⁷ Because the life science subsectors intentionally were defined to approach the range of life science activity in a broad fashion, the definition is highly suitable for comparisons between the state and national levels, as well as among Missouri's metropolitan regions.

Although the *MarketPlace* data are among the best available for studying current employment and economic activity on a regional level, they must be interpreted with caution. The data are obtained voluntarily from establishments through telephone interviews, and thus no privacy restrictions are imposed upon the reproduction or usage of the data. Since the individual establishments to be interviewed are most often identified through credit reports or requests for corporate credit, very early stage companies or firms that have not applied for credit are regularly overlooked.

The survey coverage has broadened over its period of operation so that comparisons across a number of years tend to exaggerate growth trends (though this is less true of the life sciences and other economic sectors that have received more constant attention). For this reason, this economic analysis endeavors to report growth trends in comparative fashion, describing state and metropolitan growth in the context of national industry expansion or in relation to the trends evidenced across the entire private sector. While the coverage of established private-sector firms now is quite thorough, the *MarketPlace* survey tends to be less complete with regard to public and nonprofit establishments.⁸ In addition, no distinction is made between full- and part-time employment, and age data are lacking for many establishments.

The voluntary and self-reporting nature of the data acquisition procedures leads to a further measure of care in interpretation, particularly with regard to individual

⁶ ES-202 is the common name for the Covered Employment and Wages Program, involving the Bureau of Labor Statistics of the United States Department of Labor and the various State Employment Security Agencies. ES-202 data differ from *MarketPlace* data in collection methodology, coverage, content, and release dates.

⁷ Since only portions of the survey are updated in any particular quarter, the data should not vary by quarter in any systematic fashion. Through most of this analysis, the time periods are referenced by year only.

⁸ Nonprofit organizations and some public agencies and institutions at the state and local levels are included in this analysis (to the extent that they are included in the *MarketPlace* survey); but, federal government establishments and matriculatory educational institutions are excluded, with the exception of military hospitals and medical training sites.

establishments. As is typical with sources of establishment-level economic data, the information is most reliable in aggregate form. Therefore, this analysis focuses primarily on the overall life science sector and its component subsectors. Some limited industry data at the four-digit (or more detailed) SIC level is included in the report; the Appendix contains tables that present the data at the four- to eight-digit SIC level of detail. It should be emphasized that the *MarketPlace* data refer to establishments, often listing and classifying multiple-site firms—such as branch plants or local offices—as establishments separate from their parent entities.

To some extent, these surveying irregularities and data analysis cautions merely mirror the difficulties inherent in circumscribing a static definition around the continually evolving life-science sector. Fortunately, they do not conceal the overriding purposes of this economic analysis: to examine the broad aspects of the life sciences in Missouri, to uncover and describe particular strengths, and to identify opportunities for continued expansion and development.

PROFILE OF THE MISSOURI LIFE SCIENCE SECTOR

The life science sector is continuing to grow in extent and importance within the national economy. As of the third quarter of 2001, there are nearly 70,000 life science establishments across the country, employing more than 6.8 million workers (see Table 2). Over the past 5.75 years, life science employment has expanded by 7.3 percent, well behind the pace

Key Points—Profile of the Missouri Life Science Sector

- The 1,815 life science establishments in Missouri employ more than 193,000 workers.
- Between 1995 and 2001, the Missouri life science sector increased its employment level by 11.0 percent, compared with 7.3 percent growth across the United States.
- The life science sector accounts for a 14 percent larger share of employment in Missouri than nationwide.
- Life science establishment growth has been fastest in St. Louis and Kansas City, whereas employment growth has been strongest outside of major metropolitan regions.

Table 2. Summary Data, Life Science Sector (1995 and 2001)

Metric	Missouri	St. Louis	Kansas City	rest of Missouri	United States
Establishments, 1995	1,346	533	362	451	51,934
Establishments, 2001	1,815	737	496	582	68,781
Change in number of establishments, '95-'01	469	204	134	131	16,847
% Establishment growth, '95-'01	34.8	38.3	37.0	29.0	32.4
Employment, 1995	174,020	85,177	39,581	49,262	6,349,767
Employment, 2001	193,117	74,211	50,290	68,616	6,810,918
Change in employment, '95-'01	19,097	(10,966)	10,709	19,354	461,151
% Employment growth, '95-'01	11.0	(12.9)	27.1	39.3	7.3
Employees per establishment, 1995	129.3	159.8	109.3	109.2	122.3
Employees per establishment, 2001	106.4	100.7	101.4	117.9	99.0
% Share, private sector employment, 1995	5.97	6.94	4.85	5.64	5.73
% Share, private sector employment, 2001	5.54	5.43	4.85	6.35	4.87
Employment location quotient, 1995	1.04	1.21	0.85	0.98	n.a.
Employment location quotient, 2001	1.14	1.12	1.00	1.30	n.a.
Change in employment location quotient, '95-'01	0.10	(0.09)	0.15	0.32	n.a.
All private sector activity:					
% Establishment growth, '95-'01	20.8	11.7	17.3	31.9	21.0
% Employment growth, '95-'01	19.4	11.3	27.1	23.8	26.3
Employees per establishment, 2001	11.7	13.7	13.7	8.8	11.5
Population, 2000 (thousands)	6,901	2,604	1,776	2,521	281,422
% Population growth, '95-'00	4.9	2.4	6.1	6.8	7.1

Data sources: Battelle calculations from Dun & Bradstreet *MarketPlace* survey, U. S. Census Bureau.

Note: n.a. = not applicable.

reported for the entire private sector (26.3 percent).⁹ In contrast, the number of life science establishments has increased by 32.4 percent, well ahead of the 21.0 percent reported throughout the private sector economy. One out of every 21 workers nationwide is employed in the life sciences.

Missouri has a sizable base in the life sciences, and the sector is expanding both in terms of establishments and employment. In 2001, some 1,815 life science establishments in Missouri employed more than 193,000 workers. Since 1995, Missouri has witnessed a net addition of 469 life science establishments, an increase of 34.8 percent, slightly in front of the national pace. Establishment growth has been stronger in the major metropolitan areas of St. Louis and Kansas City than in the rest of the state. In contrast, employment has grown fastest outside of the major metropolitan regions, with the St. Louis metropolitan area losing nearly 13 percent of its life science employment from 1995 to 2001. Over the whole region, greater than 19,000 jobs were added, for a growth rate (11.0 percent) that exceeds the countrywide rate of increase.¹⁰

Compared with the rest of the United States, Missouri has a greater proportion of its employment within the life sciences, with nearly one in 18 private sector jobs supplied by life science establishments. The location quotient for the Missouri life science sector is 1.14 in 2001, up from 1.04 in 1995, indicating that **Missouri is 14 percent more concentrated in the life sciences than the nation as a whole** (see Figure 2).¹¹ While St. Louis

Figure 2. Location Quotients

Location quotients are a common measure of the concentration of a particular industry or industry sector in a region relative to a reference area. The location quotient consists of the ratio of the share of total regional employment that is in the particular industry and the share of total employment in the reference area that is in the particular industry:

$$\text{Location Quotient} = \frac{\left(\begin{array}{c} \text{regional industry employment} \\ \hline \text{regional total employment} \end{array} \right)}{\left(\begin{array}{c} \text{reference area industry employment} \\ \hline \text{reference area total employment} \end{array} \right)}$$

A location quotient greater than 1.0 indicates that the region is relatively concentrated in the particular industry, whereas a location quotient less than 1.0 signifies relative under-representation. Throughout this report, location quotients are used to report regional and metropolitan industry concentrations relative to the United States. The minimum concentration threshold for declaring a regional specialization is a matter of judgment and varies somewhat in the relevant literature. In this analysis, regional specializations are defined by location quotients of 1.2 or greater.

⁹ Since the hospitals and laboratories subsector dominates the entire life science sector through its sheer size, this is partially due to slow growth in clinical life science employment; see “Composition and Specializations within the Life Science Sector.” It is also the case that growth trends for the economy as a whole tend to be overstated due to improved data collection over time, with the life science figures more likely reasonably accurate; see “Data and Methodology.”

¹⁰ Unlike the U.S. case, hospitals and laboratories helped to bolster the growth rate of Missouri’s life science sector; see “Composition and Specializations within the Life Science Sector.”

¹¹ The addition of the portions of metropolitan St. Louis and Kansas City located in Illinois and Kansas to “Missouri” does indeed add urbanized counties to the geographic area of analysis; yet, not all of the life science subsectors are disproportionately concentrated in urban areas, hence the location quotient is not unduly biased.

and Kansas City are at least as concentrated in the life sciences as the United States, it is the rest of Missouri that holds a demonstrable specialization in the life sciences, with an employment concentration 30 percent greater than the national level.¹²

¹² Again, since hospitals and laboratories dominate the overall life science sector, this is largely an artifact of the geographic distribution of Missouri's hospitals.

COMPOSITION AND SPECIALIZATIONS WITHIN THE LIFE SCIENCE SECTOR

The broad definition of the life sciences adopted for this analysis serves well to emphasize the wide range of capabilities and potential that support the Missouri life

sciences. A more explicit examination of the industry subsectors that compose the life science sector in turn allows for a greater understanding of the particular strengths and specializations upon which Missouri may build.

Key Points—Composition and Specializations within the Life Sciences

- Missouri's strengths are in the life science areas that are less technology-intensive or that present less significant potential economic impacts.
- Hospitals and laboratories dominate the Missouri life science sector and have gained 17.5 percent in employment in six years.
- Excluding hospitals and laboratories, the Missouri life science sector has performed far below the national level in recent years, actually declining in employment by 7.6 percent since 1995.
- Employment in drugs and pharmaceuticals has declined by more than 4,200, or 28.7 percent, despite large establishment increases.
- Organic and agricultural chemicals, with a location quotient of 1.11, has added only 1.3 percent in employment since 1995, following slow national declines.
- With nearly double the national concentration, food and nutrition is the strongest Missouri specialization; yet, employment has held steady.
- Missouri's employment in medical devices and instruments is small and has dropped by 7.4 percent in six years.
- Research and testing is the smallest of the six subsectors in Missouri, with 5,900 employees, and has evidenced establishment creation below national rates along with only modest employment growth in recent years.
- Large, fast-growing life science industries in Missouri include agricultural chemicals (non-fertilizer), specialty hospitals, and cheese production.
- Missouri's medical laboratories industry is large and has grown 14 percent faster than nationwide in terms of employment since 1995.
- Traditional strengths of the Missouri life science sector include pharmaceutical preparations, surgical and medical instrument manufacturing, and prepared feeds.

life science employment. The drugs and pharmaceuticals subsector tends toward larger establishments than the other two subsectors, with roughly half the number of establishments but 87 workers per establishment on average, double the figures for medical

Life Science Subsectors—United States

At the national level, by far the largest of the six sub-sectors is hospitals and laboratories—the clinical side of the life sciences. More than 32,000 establishments employing over 5 million workers, or 74.2 percent of all life science employment, compose the national hospitals and laboratories subsector (see Table 3). This subsector is large enough that it tends to dominate the overall life science sector figures, as noted previously.

Next in size are two of the manufacturing subsectors, drugs and pharmaceuticals and medical devices and instruments, along with life science research and testing. Each of these three sub-sectors accounts for 6.0 to 6.5 percent of total national

devices and instruments and research and testing. Organic and agricultural chemicals and food and nutrition are smaller but still sizable, together accounting for 16 percent of all life science establishments and 7 percent of life science employment across the United States.

Since 1995, drugs and pharmaceuticals and research and testing have been the fastest growing life science subsectors, recording surges in employment of 39.0 percent and 36.2 percent, respectively. Establishment increases within the two subsectors have been even larger during the same time period. Medical devices and instruments also expanded at a greater rate than the overall life science sector, gaining 13.1 percent in employment in just under six years.

In contrast, the remaining three subsectors have grown little or not at all since 1995. Many new sites have been established within the hospitals and laboratories subsector; but, nationwide industry consolidation, particularly within the hospitals industry, has held employment growth to just 3.8 percent. Similarly, the number of establishments within the organic and agricultural chemicals subsector has increased; but, employment has declined in the preceding 5.75 years. Both establishment and employment numbers within the food and nutrition subsector have held almost constant.

Table 3. Subsector-Level Data (1995 and 2001)

	Food & Nutrition	Org. & Agric. Chemicals	Drugs & Pharmaceuticals	Med. Devices & Instr.	Hospitals & Labs	Res. & Testing	Total
Missouri:							
Establishments, 2001	196	116	156	232	926	189	1,815
% Establishment growth, '95-'01	16.7	20.8	31.1	21.5	40.7	65.8	34.8
Employment, 2001	9,346	7,896	10,443	8,032	151,482	5,918	193,117
Change in employment, '95-'01	39	98	(4,208)	(642)	22,537	1,273	19,097
% Employment growth, '95-'01	0.4	1.3	(28.7)	(7.4)	17.5	27.4	11.0
Employees per establishment, 1995	55.4	81.2	123.1	45.4	196.0	40.7	129.3
Employees per establishment, 2001	47.7	68.1	66.9	34.6	163.6	31.3	106.4
% Share, life science employment, 1995	5.3	4.5	8.4	5.0	74.1	2.7	100.0
% Share, life science employment, 2001	4.8	4.1	5.4	4.2	78.4	3.1	100.0
Employment location quotient, 1995	1.80	1.02	1.76	0.88	1.01	0.59	1.04
Employment location quotient, 2001	1.90	1.11	0.95	0.76	1.20	0.58	1.14
Change in employment location quotient, '95-'01	0.11	0.09	(0.80)	(0.12)	0.20	(0.01)	0.10
United States:							
Establishments, 2001	5,785	4,895	5,065	10,046	32,690	10,300	68,781
% Establishment growth, '95-'01	6.4	22.1	62.5	18.9	30.8	73.7	32.4
Employment, 2001	197,498	286,620	440,224	423,049	5,053,340	410,187	6,810,918
% Employment growth, '95-'01	0.3	(1.5)	39.0	13.1	3.8	36.2	7.3
Employees per establishment, 1995	36.2	72.6	101.6	44.3	194.9	50.8	122.3
Employees per establishment, 2001	34.1	58.6	86.9	42.1	154.6	39.8	99.0
% Share, life science employment, 1995	3.1	4.6	5.0	5.9	76.7	4.7	100.0
% Share, life science employment, 2001	2.9	4.2	6.5	6.2	74.2	6.0	100.0

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Note: n.a. = not applicable.

Life Science Subsectors—Missouri

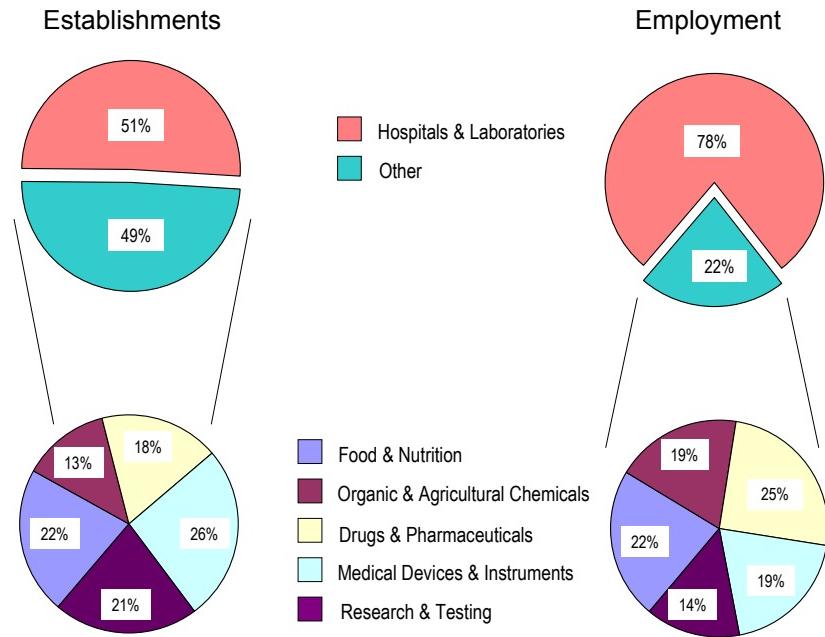
The life science strengths of Missouri are somewhat different than those of the United States as a whole. (Figure 3, identical to Figure ES1, illustrates Missouri's life science establishments and employment by subsector as of 2001; see also Table 3.) **Hospitals and laboratories dominate the Missouri life science sector to an even greater extent than nationwide**, accounting for more than half of life science establishments and more than three-quarters of life science employment. Since 1995, **employment in the hospitals and laboratories subsector has grown by more than 22,500, or 17.5 percent, substantially greater than the overall Missouri life science growth rate** and the U.S. hospitals and laboratories subsector growth rate. **The location quotient has risen from 1.01 to 1.20, signifying a specialization of the Missouri economy.**

Although hospital establishments tend to follow the distribution of population, particularly in non-urbanized areas, population growth does not explain this surge in employment in Missouri hospitals and laboratories. The Missouri population increased by 4.9 percent between 1995 and 2001, whereas the U.S. population expanded by 7.1 percent. Rather, it seems that the subsector has evidenced growth in both establishments and employment, led by regional industry strengths, more than countering the negative effects of the national trend toward consolidation and rationalization within the hospital industry.¹³ This subsector incorporates general hospitals, including Barnes-Jewish in St. Louis and St. Luke's in Kansas City, as well as specialty hospitals such as Mercy Children's Hospital and medical laboratories such as SmithKline Beecham's clinical laboratories, LabOne, and Quest.

After hospitals and laboratories, the next largest life science subsector in Missouri is drugs and pharmaceuticals, with 10,443 employees spread across 156 establishments. **The Missouri drugs and pharmaceuticals subsector has declined dramatically between 1995 and 2001.** Employment in the subsector has fallen by more than 4,200 since 1995, a decline of 28.7 percent, despite a substantial increase in the reported number of establishments (31.1 percent).¹⁴ This suggests that, while a good amount of new firm formation and turnover remains in smaller companies, larger employers are downsizing, consolidating, closing, or moving their operations out of Missouri. Indeed, the average establishment size within the drugs and pharmaceuticals sector has dropped by more than 45 percent over the past 5.75 years. This is in accord with the large amount of merger and consolidation activity taking place in the subsector both within Missouri and nationwide—for example, Mallinckrodt and Msch in St. Louis were acquired by

¹³ It is no certain conclusion that consolidations indicate weakness in the industry. In fact, hospitals and hospital systems that successfully negotiate the tricky process of streamlining operations and increasing efficiency may demonstrate improved resiliency to shifting economic conditions or a greater capacity to focus their efforts upon particular regional and institutional strengths.

¹⁴ To some extent, employment declines are likely exaggerated, since Tyco International, the purchaser of Mallinckrodt as well as several other St. Louis-based chemical establishments, failed to report employment levels for many of its establishments to the *MarketPlace* survey. In addition, although only a minority of Mallinckrodt employment in 1995 was classified in the medical device and instrument manufacturing subsector, most of the employment reported by Tyco in 2001 falls within this subsector, though the total is still far less than Mallinckrodt's reported employment level in 1995. Thus, perhaps some of the employment loss recorded in the drugs and pharmaceuticals subsector is recouped in the medical device and instrument manufacturing subsector. Nevertheless, it is clear that, overall, significant reductions in employment have resulted from Tyco's purchase and consolidation of chemical establishments in St. Louis.

Figure 3. Establishments and Employment by Subsector, Missouri (2001)

Tyco International, and Marion Merrell Dow in Kansas City merged with Hoechst and more recently became Aventis. The location quotient for the subsector has fallen dramatically, from 1.76 and a strong specialization in 1995 to only 0.95 in 2001. Major firms in this subsector currently in Missouri include Tyco, Forest Pharmaceuticals, KV Pharmaceuticals, and Aventis.

The food and nutrition subsector has remained stable in Missouri since 1995, as it has nationwide. While displaying a small but healthy amount of establishment creation (16.7 percent), the sector has added only 39 jobs in about six years to a base of 9,300 workers. Despite the sluggishness of the industry subsector, food and nutrition remains one of the mainstays of the Missouri life science sector with a location quotient of 1.90, highest among the six life science subsectors, indicating a strong specialization. In Missouri, this subsector includes portions of Purina Mills, Kraft, Conopco, and Dairy Farmers of America, as well as processing facilities for Archer Daniels and Midland and Protein Technologies.

The medical devices and instruments subsector is small and declining in Missouri, representing one of the three life science subsectors that does not currently and has not recently constituted a regional specialization. Medical devices and instruments enterprises employ just over 8,000 workers in Missouri, a decline of nearly 650 employees

Bioinformatics

Bioinformatics is the term given to the use of computers and computing technology in solving information-based problems in the life sciences. A relatively new field, bioinformatics is generating considerable excitement for its potential to contribute to some of the most important and interesting research and discoveries in the life sciences. Current applications include the generation of databases (genomic and protein sequences, patient characteristics and biomedical responses, biodiversity, etc.), data mining and analysis techniques (to help track patients, to manage clinical or research data, to determine or predict biochemical properties and interactions, etc.), and three-dimensional modeling of existing and imagined molecular and biological structures.

Given the recent inception of the field and its inherently cross-disciplinary nature, it is not surprising that the SIC system does not serve to identify firms engaged in bioinformatics ventures. Furthermore, it is difficult to isolate bioinformatics activity since many of the units most active in bioinformatics are only small subsets—departments, or even working groups—with larger multifaceted entities. For these reasons, it is not viable to include bioinformatics as a part of this economic analysis in any quantitative fashion, beyond those firms already classified within the definition of life sciences used in this analysis. Nevertheless, the field is certainly important and dynamic enough to warrant a qualitative description.

While most of the activity in bioinformatics is clustered within the major life science research centers of the United States (e.g., Boston, San Diego, suburban Maryland, and North Carolina's Research Triangle), several Missouri firms are active in the bioinformatics arena. These include Cerner, Tripos, and Express Scripts, among others (see Table B1). This may not be an exhaustive list of the bioinformatics players in Missouri, yet it gives the sense that Missouri bioinformatics activity is concentrated around data management and manipulation—focused to a greater degree on the computer end of bioinformatics than the life science side. The industry is certainly continuing to develop: most of the firms listed have either been formed or have witnessed startling growth since 1995.

Table B1. Missouri Bioinformatics Establishments.

Firm	Location	Primary SIC classification	Missouri Presence		
			Emp. '01	Emp. % Ch. '95-'01	Bioinformatics Role
Cerner Corp.	Kansas City, MO	prepackaged software	1,633	104	healthcare data management
Express Scripts	Maryland Hts., MO	medical insurance claims	1,200	94	pharmacy benefit management
Incyte Genomics	St. Louis, MO	biological research	375	n.a.	genomic databases
Microsense, Inc.	Springfield, MO	prepackaged software	8	300	medical software
Monsanto	St. Louis, MO	physical research	14,700*	n.a.	agricultural and genomic data
PC Innovators (SynApps)	St. Louis, MO	computer programming	3	n.a.	custom medical/genomic software
RxCCI	Lees Summit, MO	pharmaceutical wholesale	62	n.a.	clinical trial data management
Tripos, Inc.	St. Louis, MO	computer programming	114	27	molecular analysis software

* Employment listed for Monsanto is world-wide, from 2000 Annual Report.

in the past 5.75 years.¹⁵ This 7.4 percent reduction contrasts with the 13.1 percent growth rate reported for the subsector across the nation. As with the drugs and pharmaceuticals subsector, relatively good establishment growth in the medical devices and instruments subsector (21.5 percent, compared with 18.9 percent nationwide)

¹⁵ In addition, this decline may be somewhat masked by the reclassification of some employment from the drugs and pharmaceuticals subsector to the medical device and instrument manufacturing subsector; see footnote 14.

suggests that employment declines are due to closures, consolidations, downsizings, or out-migrations of large employers, while the subsector remains dynamic in terms of new and smaller companies. Medical device and instrument manufacturing involves Tyco (Mallinckrodt and Kendall Sherwood), Bausch and Lomb, and Baxter, among others.

Similar in size to medical devices and instruments, the recent performance of the organic and agricultural chemicals subsector is similar to that of the food and nutrition subsector.

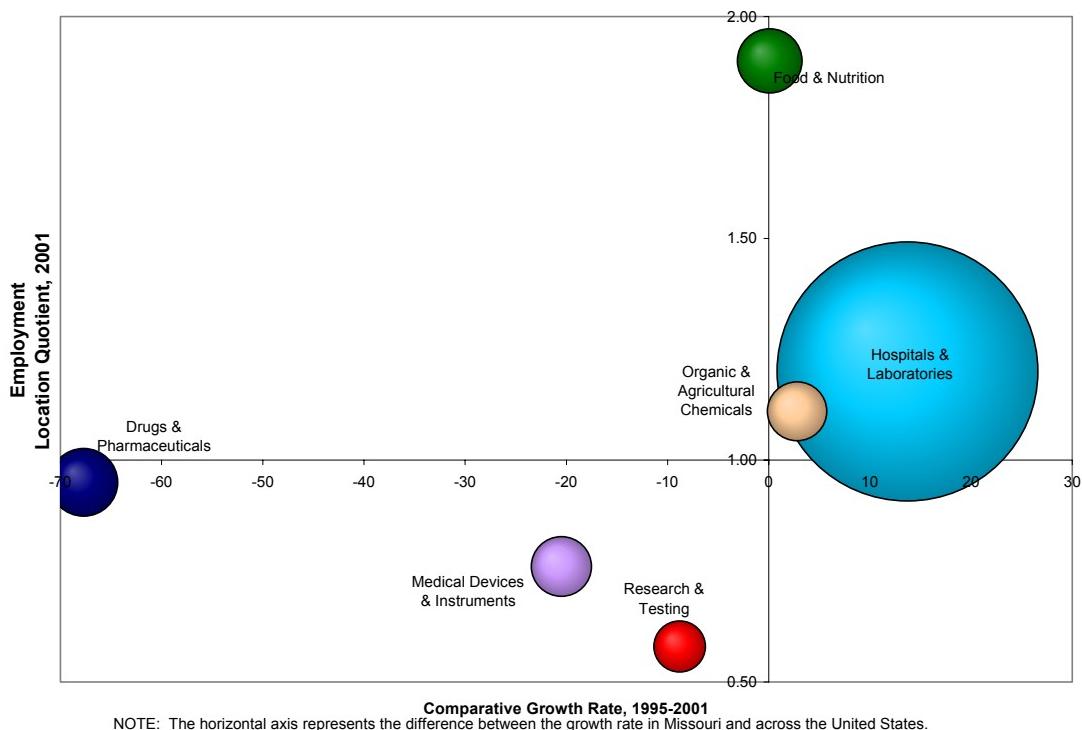
The organic and agricultural chemicals subsector has only slight employment growth within Missouri, adding nearly less than 100 jobs, or 1.3 percent, since 1995, following slowly declining employment in the subsector at the national level. The location quotient climbed from 1.02 to 1.11. Establishment growth, on the other hand, was slightly below the nationwide rate, and well under the rate for the entire Missouri life science sector. This subsector has also witnessed merger and consolidation activity, in particular Monsanto's merger and more recent split from Pharmacia-Upjohn and Solutia. Other organic and agricultural chemicals firms in Missouri include Conopco (Chesebrough-Ponds), Chemsico, and Bayer.

Finally, research and testing, the most dynamic of the life science subsectors at the national level, shows evidence of rapid firm formation in Missouri. The number of establishments has risen from 114 to 189 during the past six years, an increase of 65.8 percent—lower than the national benchmark, but substantially ahead of the rest of the life sciences as well as the private sector as a whole in Missouri. Most of the new establishments remain relatively small, however; **employment in the subsector grew a rather more modest 27.4 percent**, below the national subsector rate of 36.2 percent, to reach approximately 5,900 workers. The location quotient, nearly unchanged from its 1995 level at 0.58, indicates that **Missouri has less than 60 percent of the concentration of research and testing employment found across the United States.**

As the core of what is popularly thought of as “biotechnology,” the frequent firm creations suggest the presence of active entrepreneurialism as well as possible commercializable opportunities arising from Missouri-based research efforts. The slower rise in employment, however, may raise some concern over the degree of success achieved by fledgling and entrepreneurial efforts in this crucial segment of the life sciences. The subsector is composed of both Missouri-based companies, such as Monsanto (environmental health laboratories), Purina Mills, and ABC Laboratories, and branch sites of national and international firms, including Eagle-Picher Industries, Quintiles, Incyte Genomics, and Pharmacia.

As a further illustration, Figure 4 depicts the six Missouri life science subsectors classified by employment size, comparative growth rate, and relative concentration. The area of each disk corresponds to the amount of employment in that subsector. Although most of the subsectors are near the national level of concentration, food and nutrition is almost double, whereas life science research and testing is only slightly above half. Both organic and agricultural chemicals and hospitals and laboratories are growing more rapidly within Missouri than across the nation; but, medical devices and instruments, research and testing, and especially drugs and pharmaceuticals are behind the national pace of growth. The hospitals and laboratories sector is large enough that it largely drives the entire Missouri life science sector; **when hospitals and laboratories are excluded, Missouri's life science sector has performed far worse than the nation, with an employment decline of 7.6 percent.** Perhaps most importantly, the three subsectors in the bottom left quadrant of the graph, with lower than average concentrations and negative comparative growth rates, are usually considered to be the higher technology and more economically influential life science subsectors. Food and

Figure 4. Missouri Life Science Subsectors



nutrition in particular is less technology-based than the other life science subsectors, while the hospitals and laboratories industries do not tend to be influential economic drivers or generate substantial life science employment outside of the subsector. In other words, **the subsectors currently demonstrating strength within the Missouri life science sector are those that tend to be less technology-intensive and have less economic impact potential.**

Environmental Life Science

Another subfield of the life sciences worth exploring in more depth is environmental life science. Whereas environmental science itself is hardly a new field, the application of life science for environmental purposes has developed concurrently with the high-technology life sciences. Because of this origin spanning multiple disciplines, environmental life science activity is found in many locations across the country, yet also presents some degree of clustering near the major national life science centers (particularly for research and applications at the higher end of the technological scale). Environmental life science covers a wide range of life science applications, from the biochemical analysis of water, air, soil, and waste products to the design of pesticides and herbicides; from food contamination testing to the genetic construction of microbes for use in environmental remediation.

Unfortunately, the SIC system fares little better in uniquely identifying the cross-disciplinary field of environmental life science than it does with bioinformatics. The majority of environmental life science firms, however, do tend to be classified in industry segments already identified as parts of the life science sector for the purposes of this economic analysis—mixed into particular eight-digit SIC categories within medical devices and instruments and research and testing. Thus, the establishments and employment that constitute environmental life science in Missouri cannot be isolated for separate analysis, but are in essence already contained within the quantitative portion of the economic analysis.

Numerous Missouri firms are active in environmental life science. ABC Laboratories, Environmetrics, and the Midwest Research Institute are among the companies involved (see Table B2). Again, this does not purport to be a complete list of Missouri's environmental life science actors. Nevertheless, it is possible to grasp the range of different activities involved in environmental life science in Missouri—from water testing to the manufacturing of tailor-made microbes. Recent years may have been less kind to environmental life science establishments than to bioinformatics; several of those listed have declined significantly in employment over the past six years.

Table B2. Missouri Environmental Life Science Establishments.

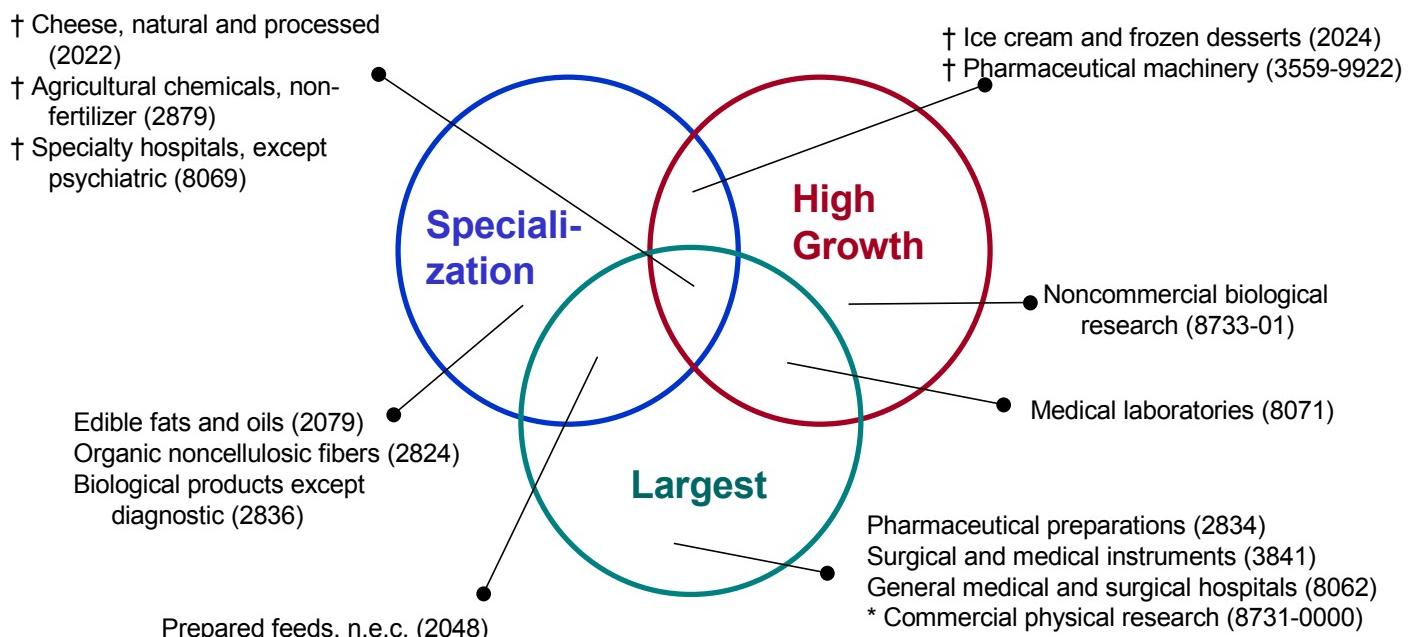
Firm	Location	Primary SIC classification	Missouri Presence		
			Emp. '01	Emp. % Ch. '95-01	Environmental Life Science Role
ABC Laboratories	Columbia, MO	research laboratory	200	1	crop & animal health, env.-chem. impacts
Baird Scientific	Carthage, MO	testing laboratories	1	0	air, water, and materials analysis
Biological Services, Inc.	Kansas City, KS	food testing	3	0	bacteriological testing
Environmental Analysis, Inc.	Florissant, MO	medical laboratories	10	-55	soil and water analysis
Environmetrics, Inc.	St. Louis, MO	testing laboratories	22	-41	waste and water testing
HEMCO Corp.	Independence, MO	laboratory apparatus	30	-25	carbon/HEPA filter manufacturing
Microbe Inotech Laboratories	Bridgeton, MO	biological research	11	83	bioremediation, microbe manufacturing
Midwest Research Institute	Kansas City, MO	nonphysical research	403	-11	chem., environm., and pharm. research
Stewart Agric. Res. Services	Clarence, MO	biological research	11	-62	environm.-chemical safety testing

Detailed Industry Strength Classification

In addition to examining the life science subsectors, it is useful to delve further, isolating particular strengths at the industry-specific level. Caution must be used in interpreting the information that is available at the level of disaggregation represented by four-digit (or more detailed) SIC categories—not only do smaller absolute numbers exaggerate standard metrics and comparisons, but, as a rule, the data are less reliable at this level of detail. Imprecisions aside, an inspection of the disaggregated data sometimes reveals particular pockets of strength or dynamism. Data tables organized at the detailed industry level are included in the Appendix.

Table 4 and Figure 5 highlight some of the key life science industries in Missouri. Figure 5 is based upon a classification scheme that identifies three main sources of industry strength—size, regional specialization, and growth rate.¹⁶ **The most robust base for life science development and expansion is likely to consist of those industries that constitute specializations, contribute substantial employment and wages to the state, and are growing and sectoral trends.**

Figure 5. Key Missouri Life Science Strengths



¹⁶ Indicates increase in location quotient, 1995-2001.

* Partial SIC category, as indicated in Table 1

n.e.c. = not elsewhere classified.

¹⁶ The criteria for inclusion are: Specialization—location quotient ≥ 1.20 ; Largest—employment greater than 2,800 in 2001; High Growth—employment growth rate greater than national industry growth rate, and greater than overall Missouri private sector employment growth rate. In addition, only industries with at least three establishments and 200 employees in both 1995 and 2001 are considered.

Table 4. Detailed Industry Strengths

Primary Industry Strengths		
<i>Large, high-growth, regional specializations</i>		
2022	Cheese, natural and processed	15 establishments; 2,999 employees; 2.93 L.Q.; 24% employment growth beats national pace of 9%
2879	Agricultural chemicals, non-fertilizer	38 establishments; 3,220 employees; 3.88 L.Q.; gained 35% in establishments and 143% in employment
8069	Specialty hospitals, except psychiatric	272 establishments; 13,306 employees; 1.68 L.Q.; grew to strong specialization over last six years
Dynamic, Emerging Industries		
<i>High growth, promising industries, but not yet large specializations</i>		
2024	Ice cream and frozen desserts	30 establishments; 762 employees; 1.24 L.Q.; 53% employment growth and a near doubling of establishments since 1995
3559-9922	Pharmaceutical machinery	3 establishments; 328 employees; 6.08 L.Q.; three Missouri establishments increased employment by 183% in spite of 58% national decline
8071	Medical laboratories	339 establishments; 6,882 employees; 1.09 L.Q.; strong establishment (64%) and employment (74%) growth exceeded national rates
8733-01	Noncommercial biological research organizations	43 establishments; 467 employees; 0.28 L.Q.; more than doubled in establishments and tripled in employment in 6 years
Major Contributing Industries		
<i>Large, contributing substantial jobs and wages, not maintaining national expansion pace</i>		
2048	Prepared feeds, not elsewhere classified	98 establishments; 2,810 employees; 2.92 L.Q.; 14% employment decline, compared with national decline of 9%
2834	Pharmaceutical preparations	104 establishments; 7,698 employees; 0.87 L.Q.; startling decline (from 1995 L.Q. of 1.33) attributable to merger and acquisition among major firms
3841	Surgical and medical instruments	88 establishments; 4,537 employees; 1.04 L.Q.; loss of 160 employees despite 10% national rate of industry increase
8062	General medical and surgical hospitals	314 establishments; 130,594 employees; 1.17 L.Q.; 11% employment growth slower than Missouri private sector (19%)
8731-0000	Commercial physical research, not elsewhere classified	15 establishments; 2,589 employees; 0.76 L.Q.; employment down slightly from 1995, contrasting with rapid national growth in research subsector

Note: See Appendix Tables A2 through A5 for additional details. Trends are reported for the 1995-to-2001 period.

Three industries meet all three criteria in Missouri. Cheese, natural and processed (SIC 2022), is nearly three times as concentrated in Missouri as nationwide and has grown by 24.0 percent in employment since 1995, reaching nearly three times the national industry growth rate. Classified at the four-digit level, **cheese production has become the largest food and nutrition industry employer in Missouri**, just shy of 3,000 workers. Agricultural chemicals, non-fertilizer (SIC 2879), has more than doubled in employment in Missouri during the past six years and is now reporting more than 3,000 employees.¹⁷ The industry doubled its concentration and is nearly four times as concentrated in Missouri as across the United States. While it is likely that this level of expansion will

¹⁷ “N.e.c.” stands for “not elsewhere classified.”

moderate over time, **agricultural chemicals has developed into a basic strength of the Missouri life science sector.** Lastly, specialty hospitals, except psychiatric (SIC 8069), has gained employment in Missouri more than four times as fast as the national industry pace, swelling to more than 13,000 employees and a location quotient of 1.68. This vigorous growth, particularly in an industry experiencing a nationwide trend toward rationalization of employment, implies that **specialty hospitals constitutes an essential underlying strength of the Missouri hospitals and laboratories subsector.**

Industries that are smaller or that do not constitute specializations but are enjoying rapid employment increases hold promise as emerging life science concentrations. Within the food and nutrition subsector, ice cream and frozen desserts (SIC 2024) employs 762 workers in 30 establishments, an increase of 14 establishments and 265 workers from 1995. This industry holds obvious connections to other large Missouri dairy industries, including cheese and milk production (SIC 2022 and 2026). Whereas pharmaceutical machinery manufacturing (SIC 3559-9922) is a particularly narrow industry segment composed of only three establishments in Missouri, employment has nearly tripled between 1995 and 2001, in spite of national employment reductions approaching 60 percent. It is possible that the industry has enjoyed unusually supportive but temporary local business conditions or that the full effects of national industry decline have yet to reach the region; but, it is also possible that the industry will retain its stronghold in Missouri.

With establishment increases 20 percent in front of the national pace and employment growth 14 percent ahead, **medical laboratories (SIC 8071) may soon become a specialization of the Missouri life science sector.** Noncommercial biological research (SIC 8733-01), though still relatively small in Missouri, has more than doubled in establishments and tripled in employment in nearly six years. As part of the core of what is popularly thought of as “biotechnology,” the frequent firm formations and rapid employment expansion within noncommercial biological research indicate the presence of an active independent research base in Missouri.

Finally, industries that are large or concentrated in Missouri but that are not outpacing national and regional rates of growth may be crucial in generating spillover and spinoff activity, supporting regional supply chains, sustaining ongoing collaborative efforts, and establishing long-term economic stability through contributions of employment and payroll to the regional economy. Several biomedical manufacturing industries fit this description in Missouri. Pharmaceutical preparations (SIC 2834) has eliminated more than 1,400 jobs since 1995, largely through merger and consolidation activity among major companies, yet remains the largest non-clinical life science industry in Missouri by four-digit SIC classification with almost 7,700 employees. The slower-growing, more traditional manufacturing side of Missouri’s life science sector is well represented by surgical and medical instrument manufacturing (SIC 3841), which employs more than 4,500 Missouri workers but has lost 3.4 percent of its employment over the past six years. Within the food and nutrition subsector, prepared feeds, n.e.c. (SIC 2048), is nearly three times as concentrated in the Missouri region as nationwide, but has followed the lead of the national industry in declining by 14.2 percent in terms of employment since 1995. Although commercial physical research, n.e.c. (SIC 8731-0000), has expanded rapidly across the United States, the life science portion of the corresponding Missouri industry

has remained stable in terms of employment.¹⁸ Employment in general medical and surgical hospitals (SIC 8062) has increased at a faster rate (11.0 percent) than the national industry sector (0.9 percent), yet lags the overall expansion of the private sector of the Missouri economy (19.4 percent). This provides further evidence that consolidation at the national level is retarding the locally driven growth of the industry.

¹⁸ It should be reiterated that the U.S. figure has been determined through application of the life-science-to-non-life-science ratio within the Missouri industry category, and thus any comparisons should invoke more than the normal degree of caution; see footnote 4.

SPATIAL AND METROPOLITAN DISTRIBUTIONS

The spatial pattern of establishments and employment is important in considering the role of the life sciences in Missouri, in its major metropolitan regions, and in identifying “hot spots” of life science activity. Although this portion of the analysis can only speculate regarding the historic, political, and functional explanations for particular geographic distributions, the findings will serve to inform the other sections of this and succeeding reports.

Life Science Sector

Figures 6 through 8 illustrate the geographic locations of the establishments that form the Missouri life science sector.

While a large proportion of the life science establishments are clustered within the St. Louis and Kansas City MSAs, a significant number also are scattered through the other four metropolitan areas and the non-metropolitan portions of the State of Missouri. As might be expected, the clinical hospitals and laboratories establishments are spread rather evenly across the rural portions of the State of Missouri to maximize population reach and minimize overlaps in coverage.

Establishments within the other five life science subsectors, even where located in rural counties, are distributed in a much less even manner.

In terms of the life sciences, the St. Louis and Kansas City metropolitan areas dominate the other Missouri metropolitan areas through sheer size. **Sixty-eight percent of the life science establishments and 65 percent of the life science employment reside in either metropolitan St. Louis or metropolitan Kansas City, as does 63 percent of the Missouri region’s population** (see Table 5 and Figure 9). In fact, since life science activity tends to cluster disproportionately in urban centers—to take advantage of locations proximate to academic and governmental life science-related research as well as to other life science enterprises and to be able to attract and retain talented scientific and executive talent—it is only because certain life science subsectors are well represented outside of the two largest metropolitan areas that the dominance of St. Louis and Kansas City is not more pronounced. Of the four other MSAs, only Springfield has more than 4 percent of Missouri’s life science employment (with 12.9 percent). The non-metropolitan or rural counties account for 20 percent of Missouri’s life science establishments and 17 percent of life science employment.

Key Points—Life Science Spatial Distribution

- Approximately two-thirds of life science establishments and employment are located in metropolitan St. Louis and Kansas City.
- Food and nutrition and hospitals and laboratories are spread throughout Missouri; the other four subsectors are concentrated in the major metropolitan areas.
- Within the St. Louis and Kansas City metropolitan regions, major life science employers tend to be situated in middle-ring suburbs and not clustered.

Figure 6. Spatial Distribution of Life Science Establishments, Missouri

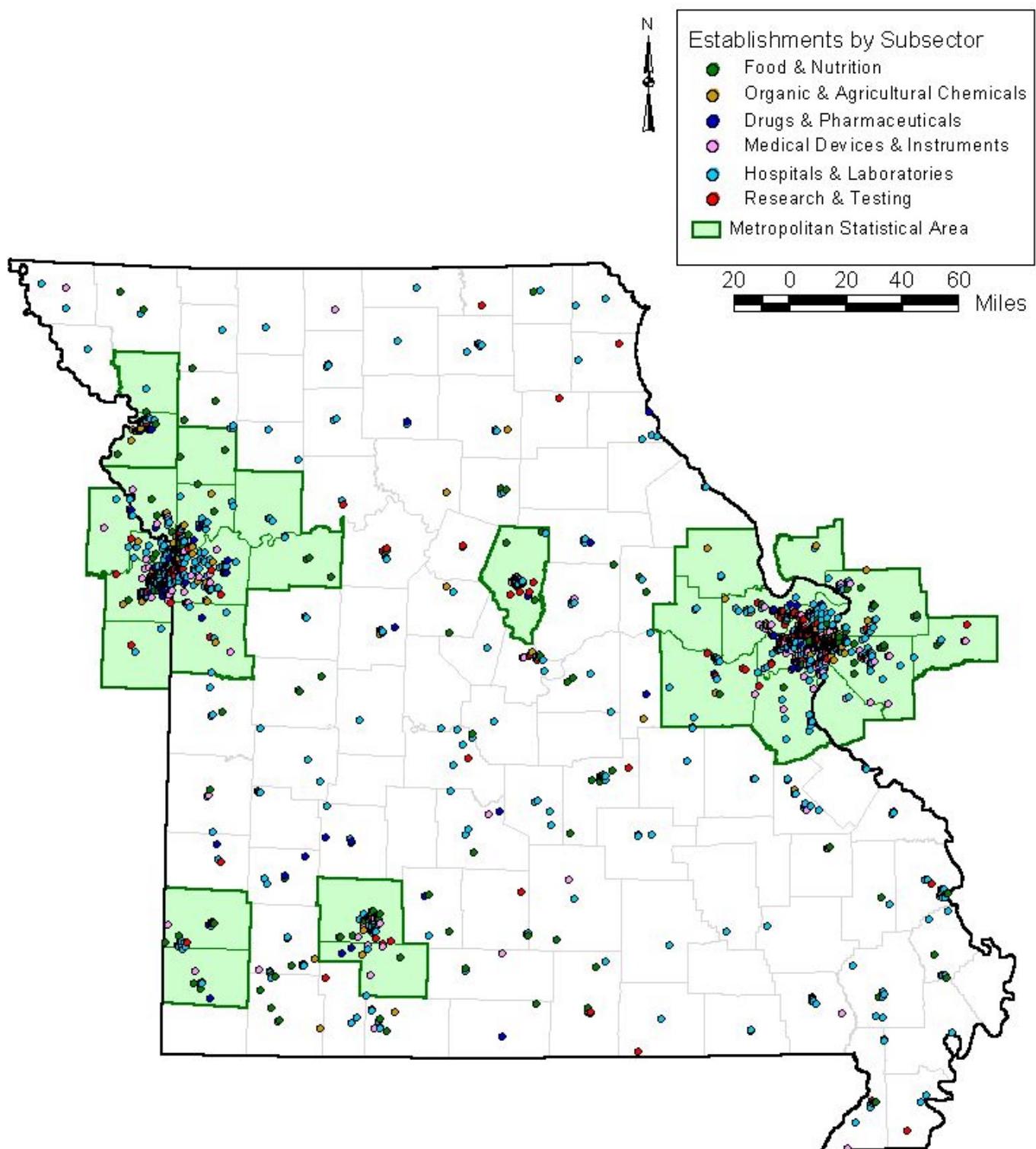


Figure 7. Spatial Distribution of Life Science Establishments, St. Louis

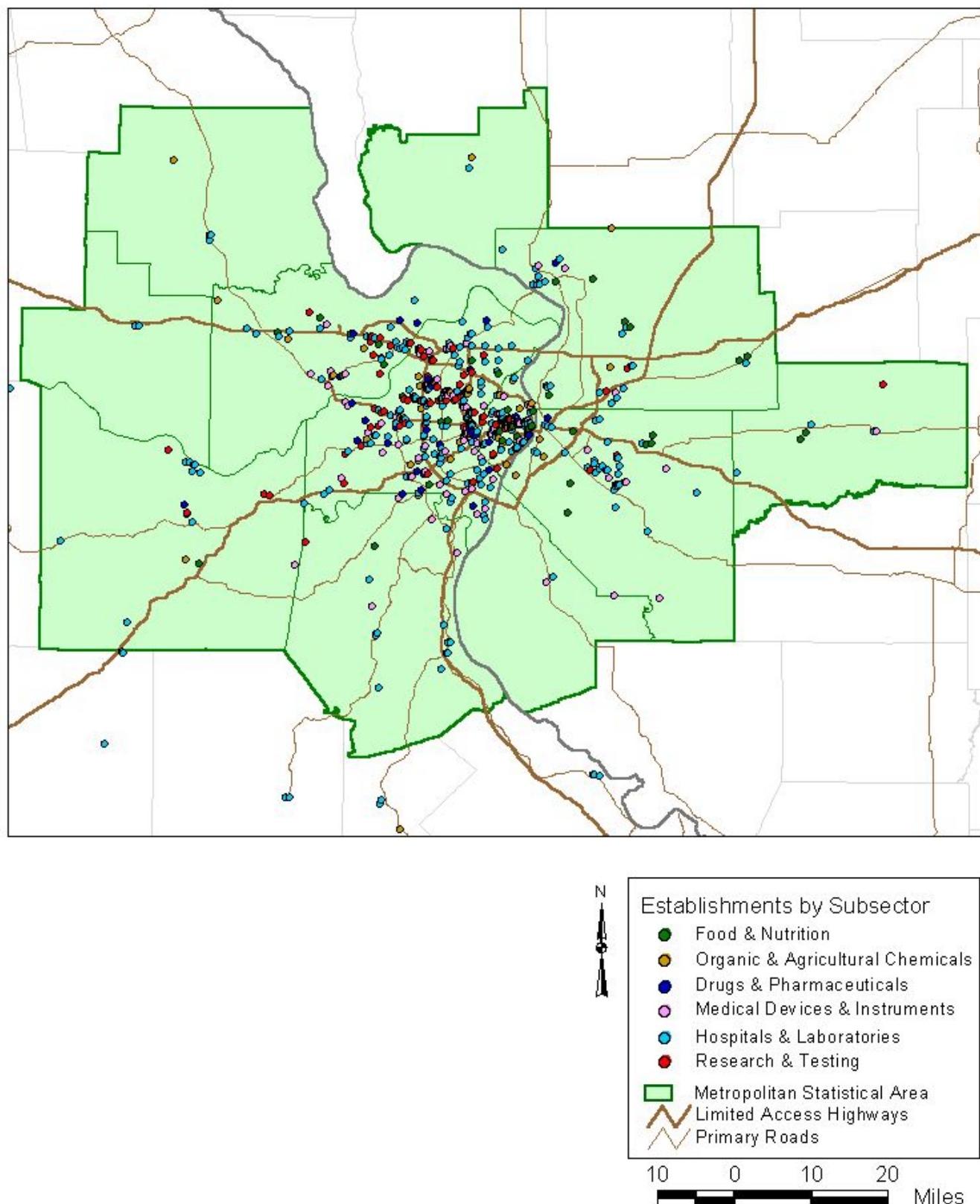


Figure 8. Spatial Distribution of Life Science Establishments, Kansas City

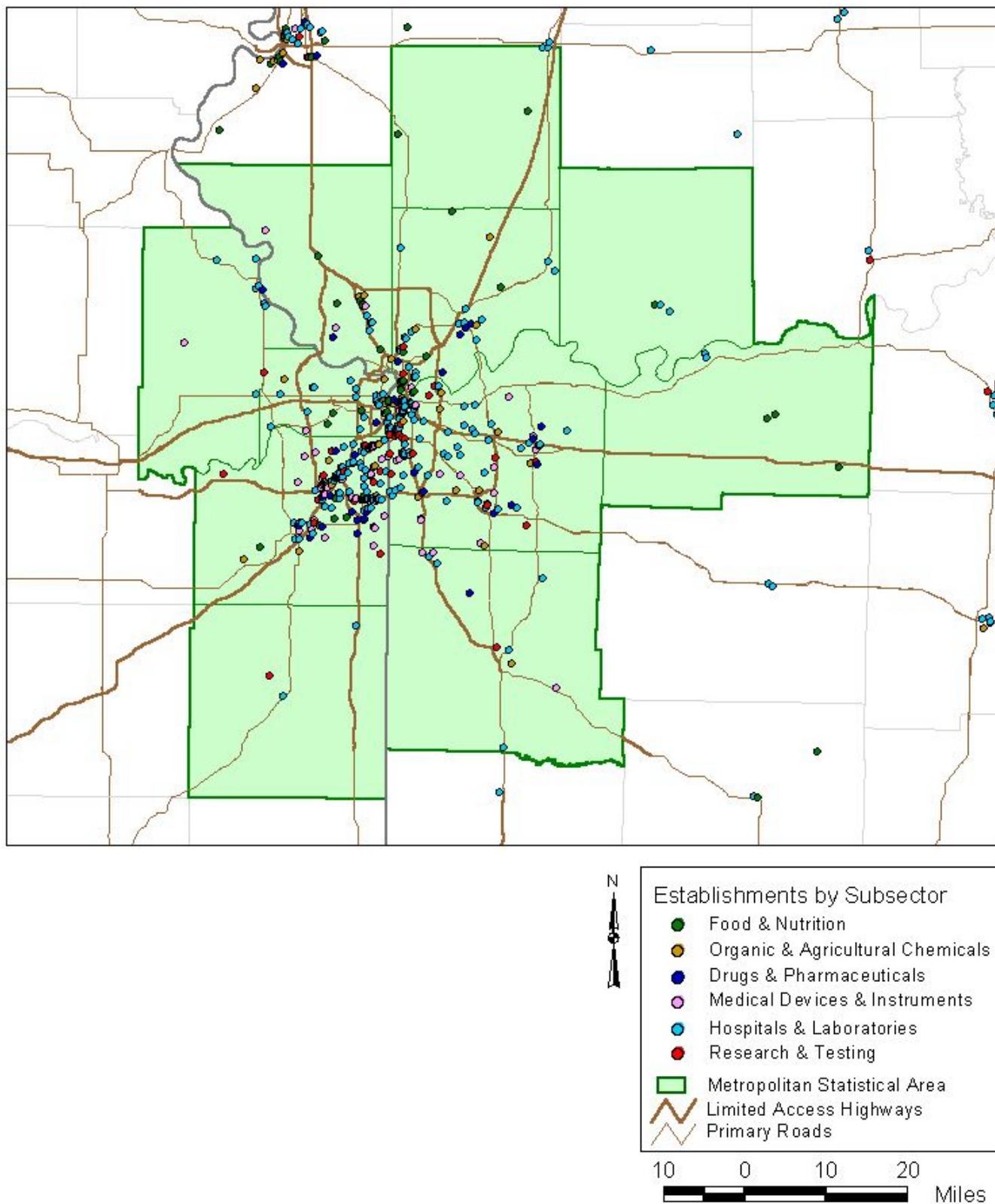
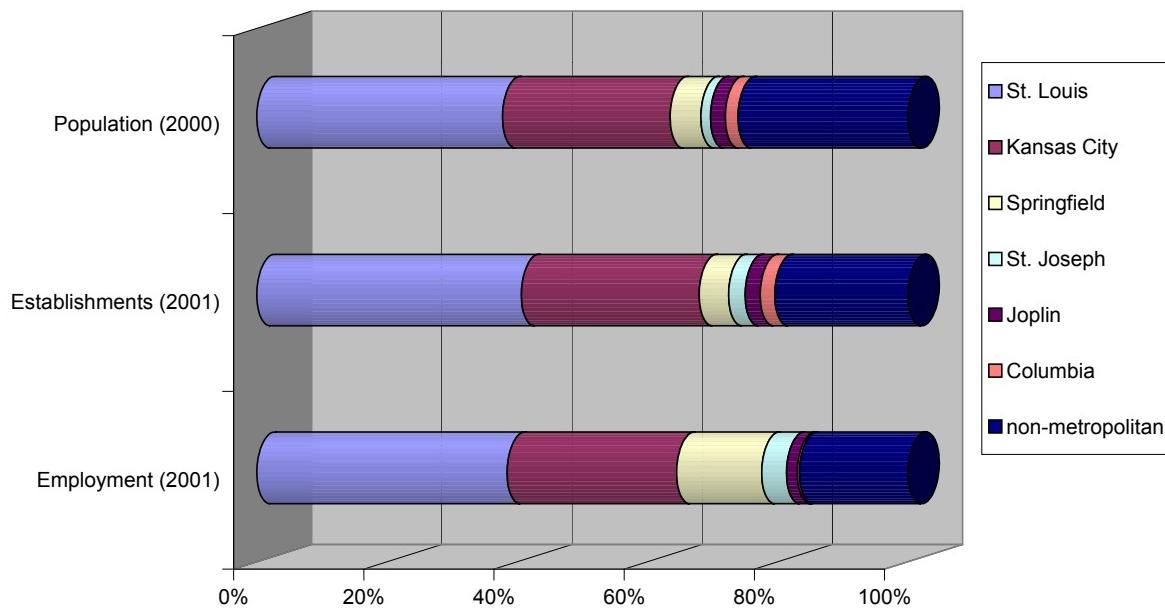


Table 5. Life Science Distribution by Metropolitan Area, Missouri (2001)

County	Life Science Sector		Food & Nutrition		Organic & Agric. Chemicals		Drugs & Pharmaceuticals		Medical Devices & Instruments		Hospitals & Laboratories		Research & Testing		Population (2000, thousands)
	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	
Total	1,815	193,117	196	9,346	116	7,896	156	10,443	232	8,032	926	151,482	189	5,918	6,901
Columbia	41	609	4	25	0	0	3	22	5	19	15	219	14	324	135
Joplin	42	3,233	7	826	0	0	2	7	6	43	24	2,349	3	8	157
Kansas City	496	50,290	40	1,156	33	864	58	2,928	72	1,591	245	42,301	48	1,450	1,776
St. Joseph	46	7,394	13	385	7	516	4	1,092	2	803	18	4,492	2	106	102
St. Louis	737	74,211	56	2,209	58	5,047	68	5,504	115	4,890	347	52,699	93	3,862	2,604
Springfield	82	25,207	16	2,044	5	345	5	130	9	75	40	22,586	7	27	326
non-metropolitan	371	32,173	60	2,701	13	1,124	16	760	23	611	237	26,836	22	141	1,800
Percent of Total															
Columbia	2.3	0.3	2.0	0.3	0.0	0.0	1.9	0.2	2.2	0.2	1.6	0.1	7.4	5.5	2.0
Joplin	2.3	1.7	3.6	8.8	0.0	0.0	1.3	0.1	2.6	0.5	2.6	1.6	1.6	0.1	2.3
Kansas City	27.3	26.0	20.4	12.4	28.4	10.9	37.2	28.0	31.0	19.8	26.5	27.9	25.4	24.5	25.7
St. Joseph	2.5	3.8	6.6	4.1	6.0	6.5	2.6	10.5	0.9	10.0	1.9	3.0	1.1	1.8	1.5
St. Louis	40.6	38.4	28.6	23.6	50.0	63.9	43.6	52.7	49.6	60.9	37.5	34.8	49.2	65.3	37.7
Springfield	4.5	13.1	8.2	21.9	4.3	4.4	3.2	1.2	3.9	0.9	4.3	14.9	3.7	0.5	4.7
non-metropolitan	20.4	16.7	30.6	28.9	11.2	14.2	10.3	7.3	9.9	7.6	25.6	17.7	11.6	2.4	26.1

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Figure 9. Missouri Life Science Distribution by Metropolitan Area



Within the St. Louis metropolitan region, life science establishments are located primarily on the Missouri side of the Mississippi River, with particular clusterings evident in three locations: the Interstate 64 corridor leading from downtown westward toward St. Louis University and the Washington University medical campus, the area surrounding the main campus of Washington University near the junction of Interstate 64 and the inner belt (Interstate 170), and the region south of Lambert International Airport including Overland and Maryland Heights. In Kansas City, both the Kansas and Missouri sides claim substantial numbers of life science establishments, with downtown Kansas City, Missouri, and the region southwest of the downtown along Interstates 35 and 435 in Lenexa and Overland Park, Kansas, evidencing the greatest establishment concentrations. Several other geographic trends are evident within particular life science subsectors.

Life Science Subsectors

Figures 10 through 15 illustrate the spatial employment distributions of the six life science subsectors, with the employment indicated in ranges by icon diameter. The life science subsectors are displayed in groups of three to reduce graphic cluttering. Table 5 provides similar information in numeric form.

The food and nutrition subsector is well dispersed across several Missouri regions. The St. Louis and Kansas City MSAs each contain more than 20 percent of the subsector's establishments. With smaller average employment per establishment, Kansas City accounts for only 12 percent of Missouri food and nutrition employment. The majority of food and nutrition establishments in the St. Louis MSA, including Purina Mills, Protein Technologies, and several dairies, are on the Missouri side of the Mississippi River, located within a few miles of downtown St. Louis. Nevertheless, food and nutrition is one of the few subsectors to maintain substantial employment on the Illinois side of the St. Louis MSA, with several dairies and food preparing and packaging firms. A number of large employers, such as Dairy Farmers of America, Schreiber Foods, and Kraft Foods, are located in Springfield, in Joplin, and in the counties located between the two small metropolitan areas. All together, the non-metropolitan regions of Missouri account for approximately 30 percent of the establishments and employment within the food and nutrition subsector.

Half of the organic and agricultural chemicals establishments and nearly two-thirds of the employment are located within the St. Louis MSA. This is in contrast to the distribution common in other regions of the country, where unpleasant operating characteristics (externalities such as noise or odor) or the agricultural or pastoral uses of the end products compel non-urbanized and dispersed locations. In St. Louis, the subsector incorporates a substantial amount of research-and-development-oriented employment, including sites for such firms as Pharmacia, Solutia, Vi-Jon Laboratories, and Protein Technologies. The concentration of organic and agricultural chemicals activity in the St. Louis region may reflect the advantages of co-location for chemicals research, including the possibilities of collaboration, labor force pooling, and bargaining power with local government.

Figure 10. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, Missouri

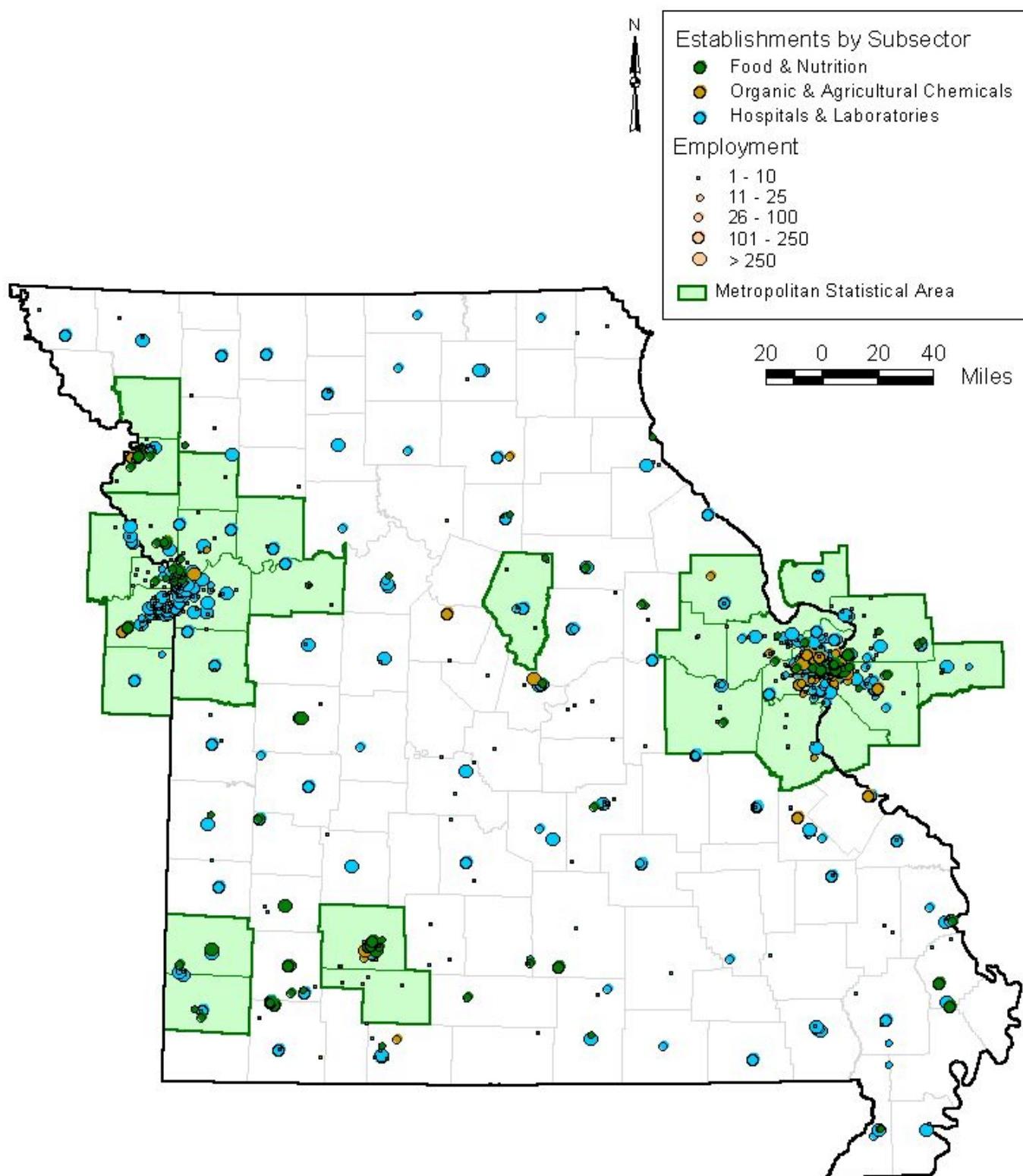


Figure 11. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, St. Louis

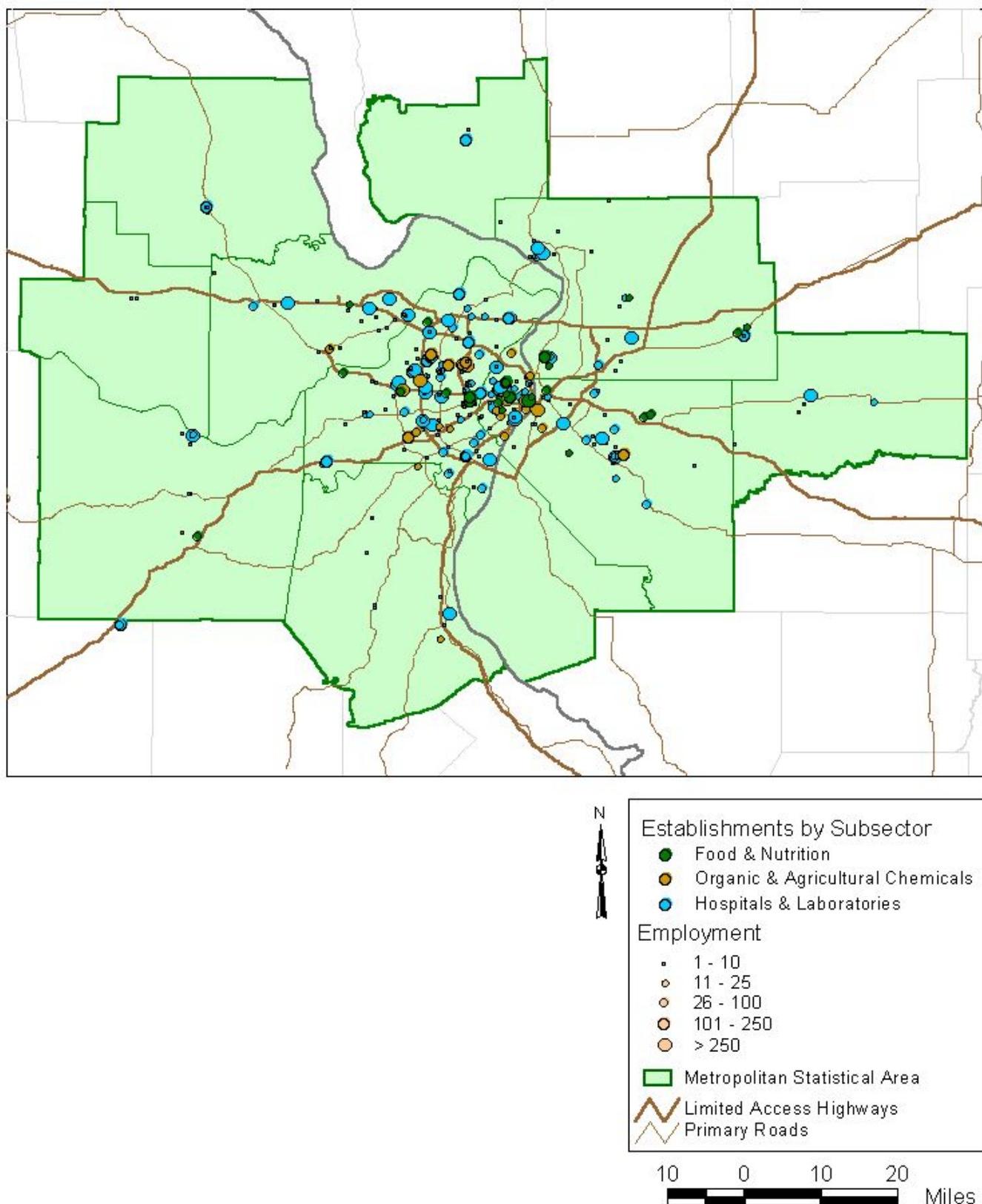


Figure 12. Life Science Employment Distribution: Food & Nutrition, Organic & Agricultural Chemicals, Hospitals & Laboratories, Kansas City

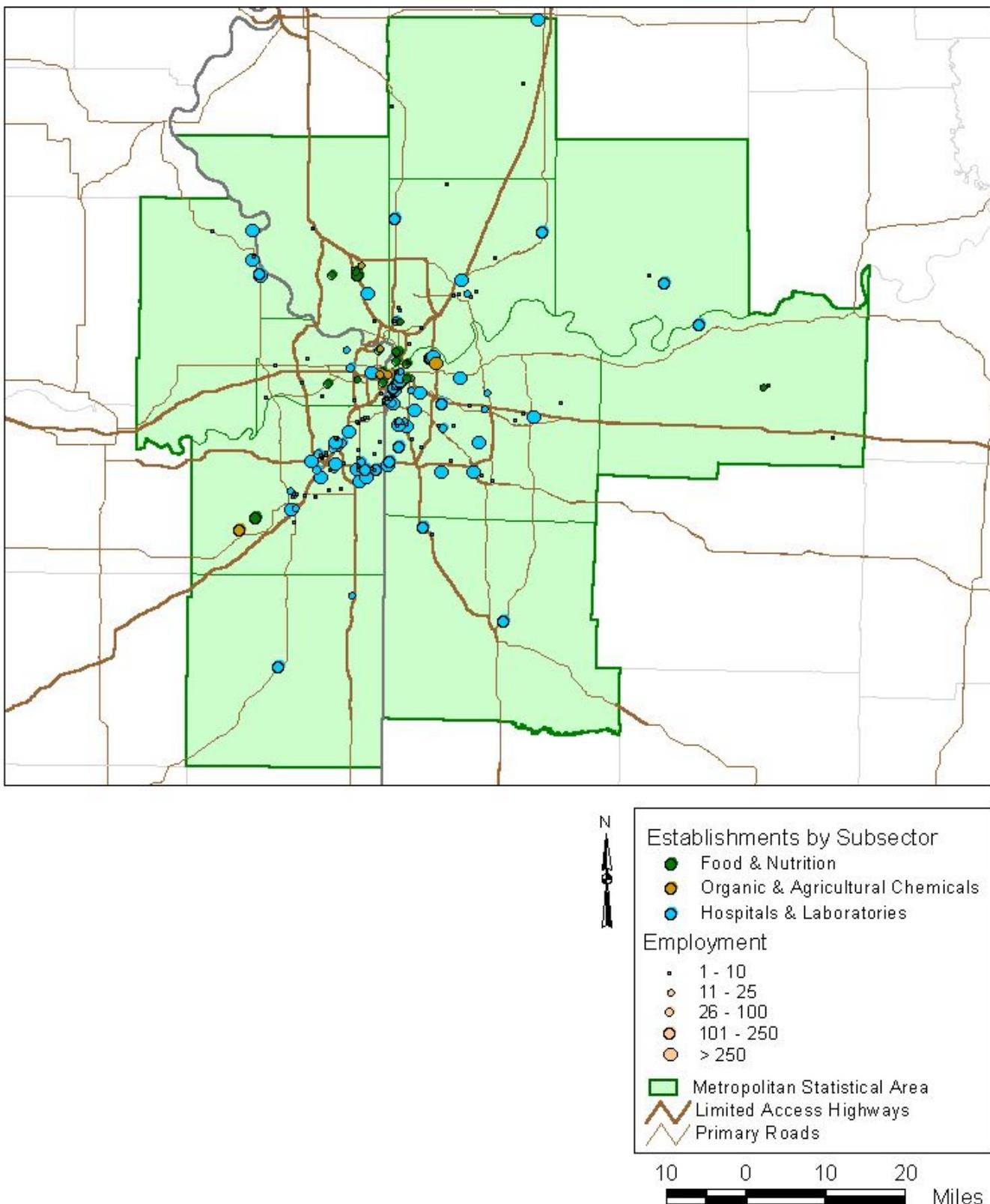


Figure 13. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, Missouri

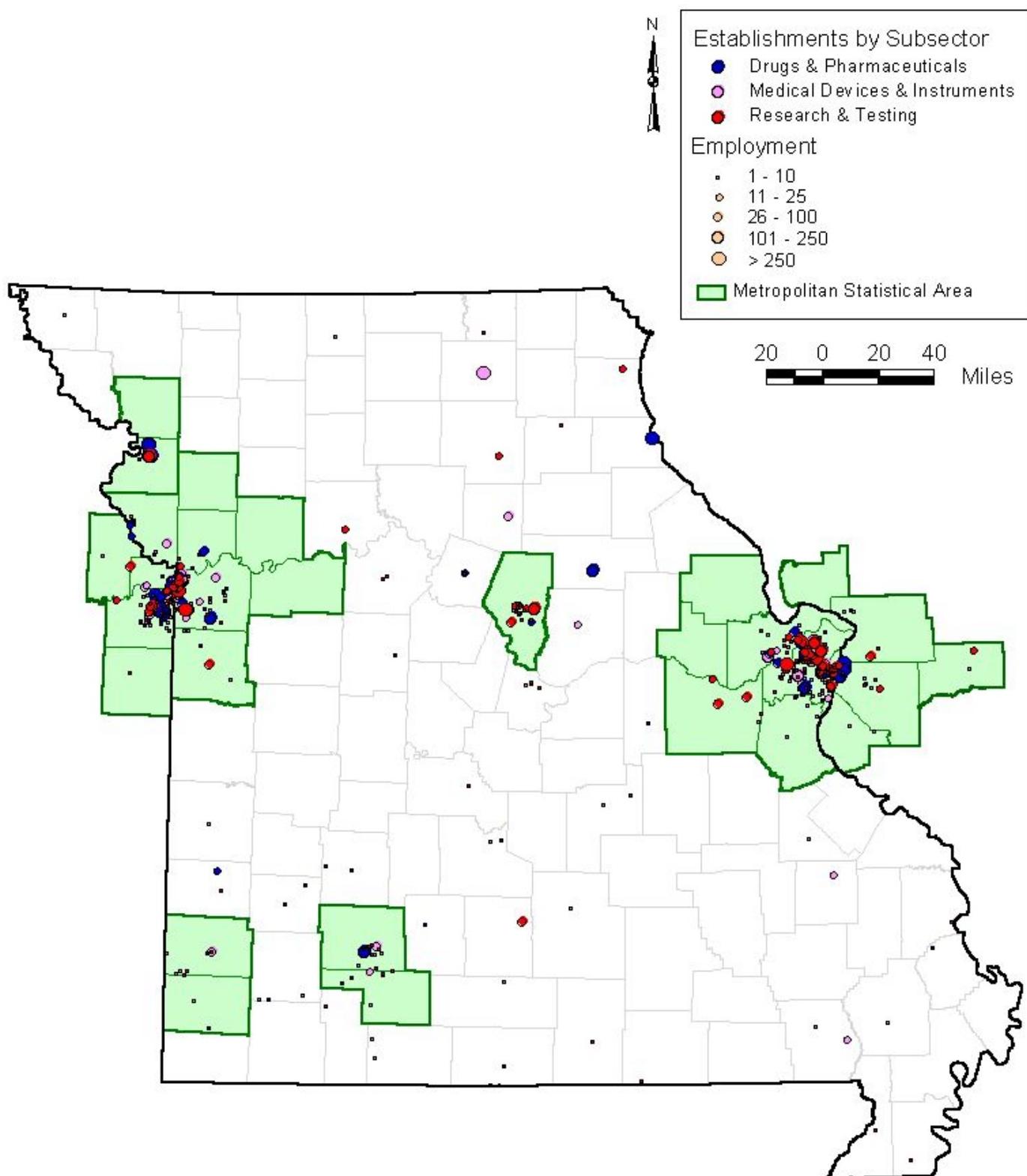
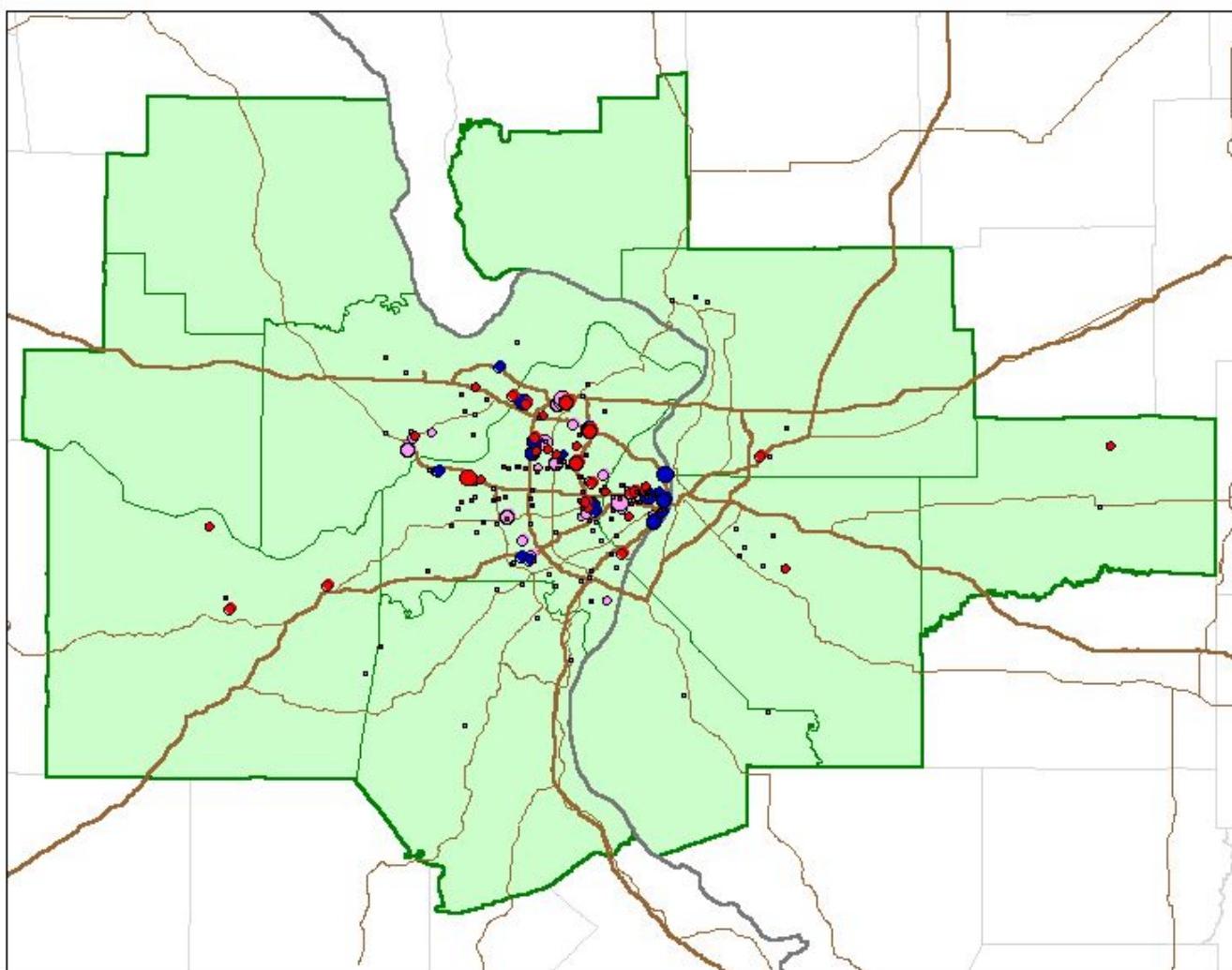
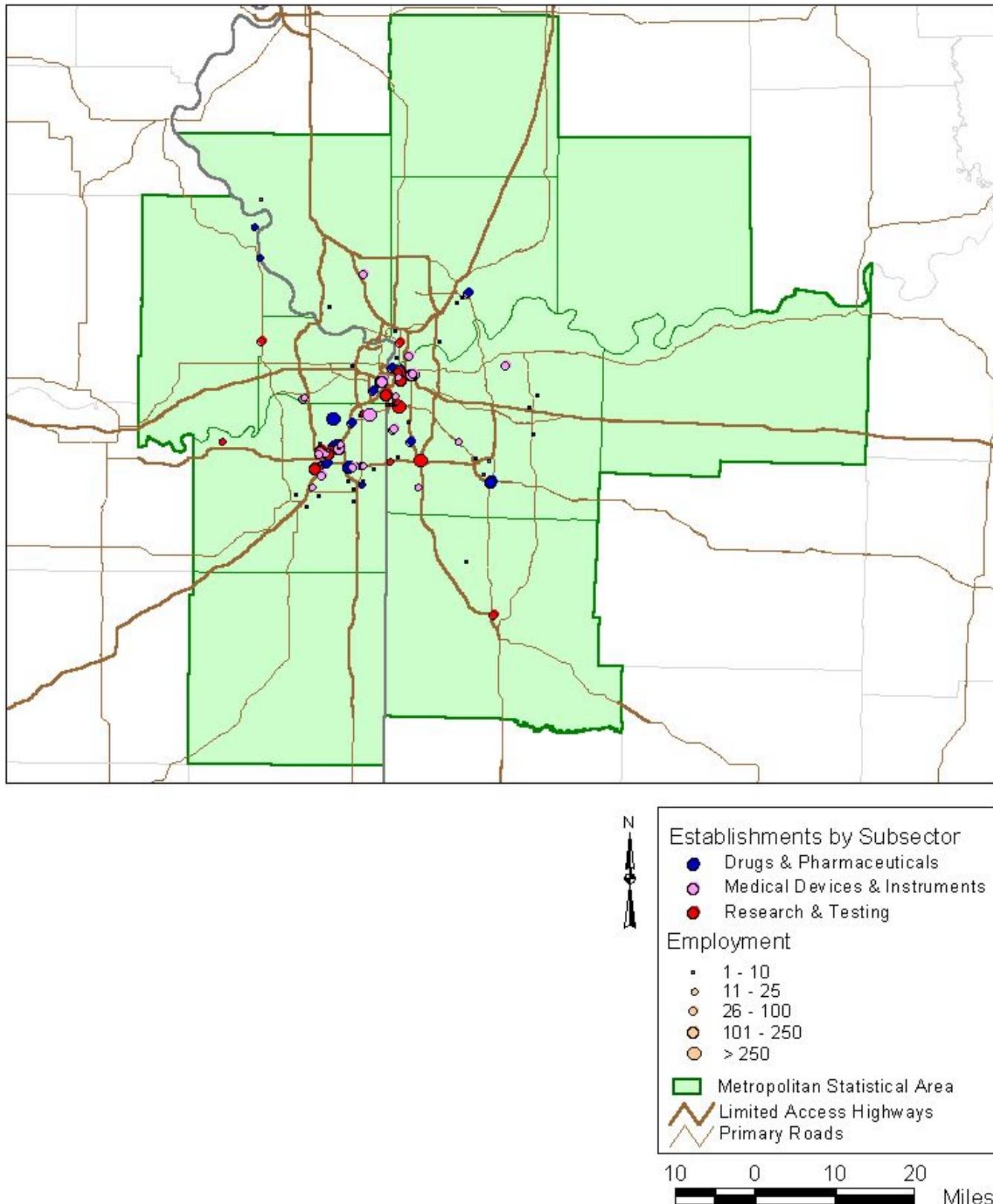


Figure 14. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, St. Louis



10 0 10 20 Miles

Figure 15. Life Science Employment Distribution: Drugs & Pharmaceuticals, Medical Devices & Instruments, Research & Testing, Kansas City



Despite claiming some 28 percent of the establishments in the subsector, Kansas City contains few large sites and less than 11 percent of the total Missouri employment in organic and agricultural chemicals. Several hundred organic and agricultural chemicals jobs are located in St. Joseph and Springfield; more than 1,100 employees work in 13 establishments located outside Missouri metropolitan areas, mainly in the counties surrounding the Columbia MSA and south of metropolitan St. Louis.

To a great extent, both **drugs and pharmaceuticals and medical devices and instruments activities are concentrated in the two major metropolitan areas of St. Louis and Kansas City.** The two MSAs together contain more than 80 percent of Missouri employment in each subsector, with St. Louis by itself accounting for 50 to 60 percent in each subsector. Within Kansas City, most of the large drugs and pharmaceuticals employers are located in the suburban areas along the southern and western portions of Interstate 435. This geographical arrangement of establishments, including such international firms as Pfizer, Aventis, Quintiles, and Rhone-Poulenc, likely reflects the suburban location preferences of the scientists, product engineers, and executives employed by the major pharmaceutical companies, as well as possible co-location and transportation advantages. Several medical devices and instruments companies are located toward the southwest of the city as well, but more of the establishments and employment are located within 5 to 10 miles of downtown Kansas City than is the case with the drugs and pharmaceuticals subsector.

In St. Louis, the medical devices and instruments companies are mainly found in the suburbs (including the Tyco-purchased Mallinckrodt concerns that were formerly classified as drugs and pharmaceuticals). Except for a few establishments near the medical campus of Washington University, the large employers in the subsector are arrayed in the western and northern suburbs. Again, this is likely due to corporate suburban-location preferences. As for drugs and pharmaceuticals, much of the employment is again located in the middle ring of suburbs to the west and the north; but, several large employers, including SmithKline Beecham, Sigma-Aldrich, and Mallinckrodt (Tyco), also are situated near downtown. One conjectural explanation is that these downtown locations represent older establishment sites than those in the St. Louis suburbs or in Kansas City. Another possibility is that firms with multiple locations in St. Louis maintain at least one downtown location for communication, transportation, political, or public relations purposes (most of the major St. Louis employers in both subsectors have multiple establishments within the MSA, and several also have establishments classified in both the drugs and pharmaceuticals and the medical devices and instruments subsectors.)

Of the smaller metropolitan areas, only St. Joseph contains a sizable amount of employment in either subsector, with roughly 10 percent of both drugs and pharmaceuticals and medical devices and instruments employment. The former concentration is due to several sizable veterinary pharmaceutical establishments, whereas the latter consists of a single large site owned by Tyco International. Only 7 to 8 percent of the employment and 10 percent of the establishments in the two subsectors are located in non-metropolitan regions of Missouri.

Turning to hospitals and laboratories, it is not surprising to find that **large hospital employment sites are spread throughout many of the rural counties in Missouri**. It is typical for hospital establishments to be somewhat more distributed toward both central and peripheral areas than the rest of the life science sector. County and outlying regional hospitals serve particular catchment areas and are often some of the largest employers in rural counties and in the county seats of peripheral metropolitan counties. In fact, non-metropolitan areas of Missouri account for 26 percent of hospital and laboratory establishments and 18 percent of employment, more than the population distribution would suggest.¹⁹ Within the Kansas City and St. Louis MSAs, the majority of sizable hospital and laboratory establishments are located inside of or near to the outer belt highways roughly defining the middle ring of suburbs (Interstate 435 in Kansas City and Interstate 270 in St. Louis). Beyond these inner regions, major hospital and laboratory establishments are, for the most part, centrally located within peripheral metropolitan counties and separated from each other, well situated to serve individual coverage areas.²⁰

Finally, life science research and testing is very highly concentrated within the Kansas City and particularly the St. Louis metropolitan areas. **Nearly half of the establishments and just under two-thirds of Missouri's research and testing employment are contained within the St. Louis MSA.** Aside from a small region along Interstate 64 near the Washington University medical center and St. Louis University, the research and testing activity is distributed through the northern and western St. Louis suburbs. This does not represent geographic clustering as such; yet, the establishments are close enough to each other and to highway routes to allow for easy interaction and resource sharing, if desired. **Kansas City accounts for approximately one-quarter of the research and testing establishments and employment in Missouri, in accordance with its population share.** A significant fraction of these establishments are grouped around the Midwest Research Institute in downtown Kansas City, Missouri, presumably either to take advantage of intellectual resources or because of spinoff origins (from the Institute or nearby University of Missouri at Kansas City or both). Columbia, despite containing only 2 percent of Missouri's population and far less than 2 percent of the employment in the other five life science subsectors, accounts for 7.4 percent of the research and testing establishments and 5.5 percent of the research and testing employment in Missouri. Unlike the manufacturing subsectors discussed in the preceding paragraphs, research and testing firms benefit directly from interaction, feedback, and spillovers from university and institutional research.

Together, these configurations seem to indicate specific spatial preferences in several of the life science subsectors. Whereas food and nutrition and hospitals and laboratories employment are dispersed across Missouri, the other four life science subsectors—research and testing, drugs and pharmaceuticals, medical devices and instruments, and organic and agricultural chemicals—are concentrated within the major metropolitan areas

¹⁹ This is at least partially because university hospitals are not included in this analysis—hence the almost complete absence of hospital employment in the Columbia MSA. In addition, though medical laboratories may not follow the same spatial pattern, hospital employment dominates laboratory employment within the subsector.

²⁰ The prominent counterexamples, one located in the northwest of the Kansas City MSA and the other to the east of the St. Louis downtown in Illinois, are explained by the presence of an Army base with its own hospital in the former case and the co-location of large laboratories with a regional hospital in the other.

of St. Louis and Kansas City. Although the activity in the manufacturing subsectors is not further clustered into smaller regions within the metropolitan areas, certain types of locations do seem to be preferred. Major sites in the drugs and pharmaceuticals, medical devices and instruments, and organic and agricultural chemicals subsectors tend to be situated in middle-ring suburban areas with convenient highway access. A substantial, if not overwhelming, portion of research and testing establishments are located reasonably close to university and other research institutions. Nevertheless, Missouri's major metropolitan regions present a contrast to the highly clustered patterns of life science activity found in other urban areas, such as Boston, San Diego, and Pittsburgh. The dispersed nature of life science activity reflects the size and maturity of the manufacturing enterprises that dominate Missouri's non-clinical life sciences, yet may also make it more difficult to target government and business support services toward small and entrepreneurial life science endeavors, particularly within the overshadowed research and testing subsector.

ESTABLISHMENT-LEVEL CHARACTERISTICS

Table 6 provides additional detail concerning the firms and establishments that compose the Missouri life science sector. **The share of Missouri's life science establishments that are young is comparable to benchmark states and the United States as a whole—approximately 28 percent were formed within the past five years** (see Figure 16).^{21,22} The share of life science employment within these establishments is smaller at just under 20 percent, as youthful firms tend to have fewer employees on average than older, more established companies. Although Missouri reports more of its life science employment within youthful establishments than the United States or the benchmark states, this is most likely exaggerated by the reorganization activity occurring within the biomedical manufacturing subsectors.

Of the four manufacturing subsectors, three report higher percentages of recent establishments than the life science sector average. Organic and agricultural chemicals leads all of the life science subsectors with nearly 38 percent of its firms established within the past five years. Although some of the recent establishment formation within the subsector is due to new

activity, reorganization following the merger and spin-off activities of Monsanto, Solutia, and Pharmacia also likely has had a significant effect. Indeed, youthful firms account for 44 percent of employment, hinting at the involvement of large establishments. The same explanation holds true for both the medical devices and instruments subsector, reporting 28 percent of its establishments containing 30 percent of employment to be five or fewer years old, and the drugs and pharmaceuticals subsector, which reports 20 percent youthful establishments accounting for 22 percent of employment. The percentage of recently established drugs and pharmaceuticals sites is quite low overall, especially once the degree of merger and acquisition activity is considered, reflecting the decline in the subsector. The food and nutrition subsector has undergone a substantial amount of establishment creation, with 31 percent of its establishments formed since 1995; yet,

Key Points—Establishment-Level Characteristics

- Fewer than 28 percent of Missouri's life science establishments are five or fewer years old; these establishments account for approximately 20 percent of employment in the sector.
- Sixty-nine percent of life science establishments in Missouri are headquarters or individual sites, exercising primary control over state or regional operations. These establishments employ 70 percent of the life science workers.
- Only 11 percent of research and testing employment is in firms five or fewer years old, and 67 percent is in branch sites, indicating a possible lack of local control and limited entrepreneurial success.

²¹ Those establishments formed in 1996 or more recently are considered youthful for the purposes of this analysis. Establishment ages are among the least reliable of the statistics available from the *MarketPlace* survey: nearly 50 percent of Missouri life science establishments failed to report their year of creation and are thus classified as of “unknown age.” The percentages reported in this section are based upon the universe of establishments for which age was reported and may be understated (overstated) if a substantial fraction of the companies of unknown age are (not) of recent establishment.

²² Again, it should be remembered that hospitals and laboratories largely dominate sectoral figures.

Table 6. Life Science Establishment Characteristics, Missouri (2001)

Metric	Food & Nutrition		Organic & Agric. Chemicals		Drugs & Pharmaceuticals		Medical Devices & Instruments		Hospitals & Laboratories		Research & Testing		Life Science Sector	
	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.	Establ.	Empl.
Totals	196	9,346	116	7,896	156	10,443	232	8,032	926	151,482	189	5,918	1,815	193,117
Establishments 5 or fewer years old	29	260	29	1,674	17	1,006	46	1,590	102	21,645	34	211	257	26,386
% in Establishments 5 or fewer years old	30.9	15.2	37.7	43.7	19.5	21.6	27.9	30.0	25.6	18.6	30.4	11.1	27.5	19.8
Non-subsidiary headquarters	24	1,051	12	2,342	8	996	20	1,437	94	76,012	11	724	169	82,562
Percent in non-subsidiary headquarters	12.2	11.2	10.3	29.7	5.1	9.5	8.6	17.9	10.2	50.2	5.8	12.2	9.3	42.8
Subsidiary headquarters	6	284	5	547	11	2,571	9	2,283	8	4,746	1	175	40	10,606
Percent in subsidiary headquarters	3.1	3.0	4.3	6.9	7.1	24.6	3.9	28.4	0.9	3.1	0.5	3.0	2.2	5.5
Subsidiary and non-subsidiary individual sites	75	392	63	939	80	1,112	153	1,619	562	37,698	117	1,059	1,050	42,819
Percent in individual sites	38.3	4.2	54.3	11.9	51.3	10.6	65.9	20.2	60.7	24.9	61.9	17.9	57.9	22.2
Non-subsidiary branch sites	91	7,619	36	4,068	57	5,764	50	2,693	262	33,026	60	3,960	556	57,130
Percent in branch sites	46.4	81.5	31.0	51.5	36.5	55.2	21.6	33.5	28.3	21.8	31.7	66.9	30.6	29.6

Data source: Battelle calculations from Dun & Bradstreet *MarketPlace* survey.

Note: The percentage of establishments 5 or fewer years old is calculated for the reduced universe of establishments for which age is known.

these sites remain small, accounting for only 15 percent of the subsector's total employment as of 2001.

Only 26 percent of hospitals and laboratories are five years old or younger, employing 19 percent of the total hospital and laboratory workforce. This is in accord with the contrasting effects of growth from population expansion and locally supported industry development in Missouri and continuing national consolidation of the hospital industry.

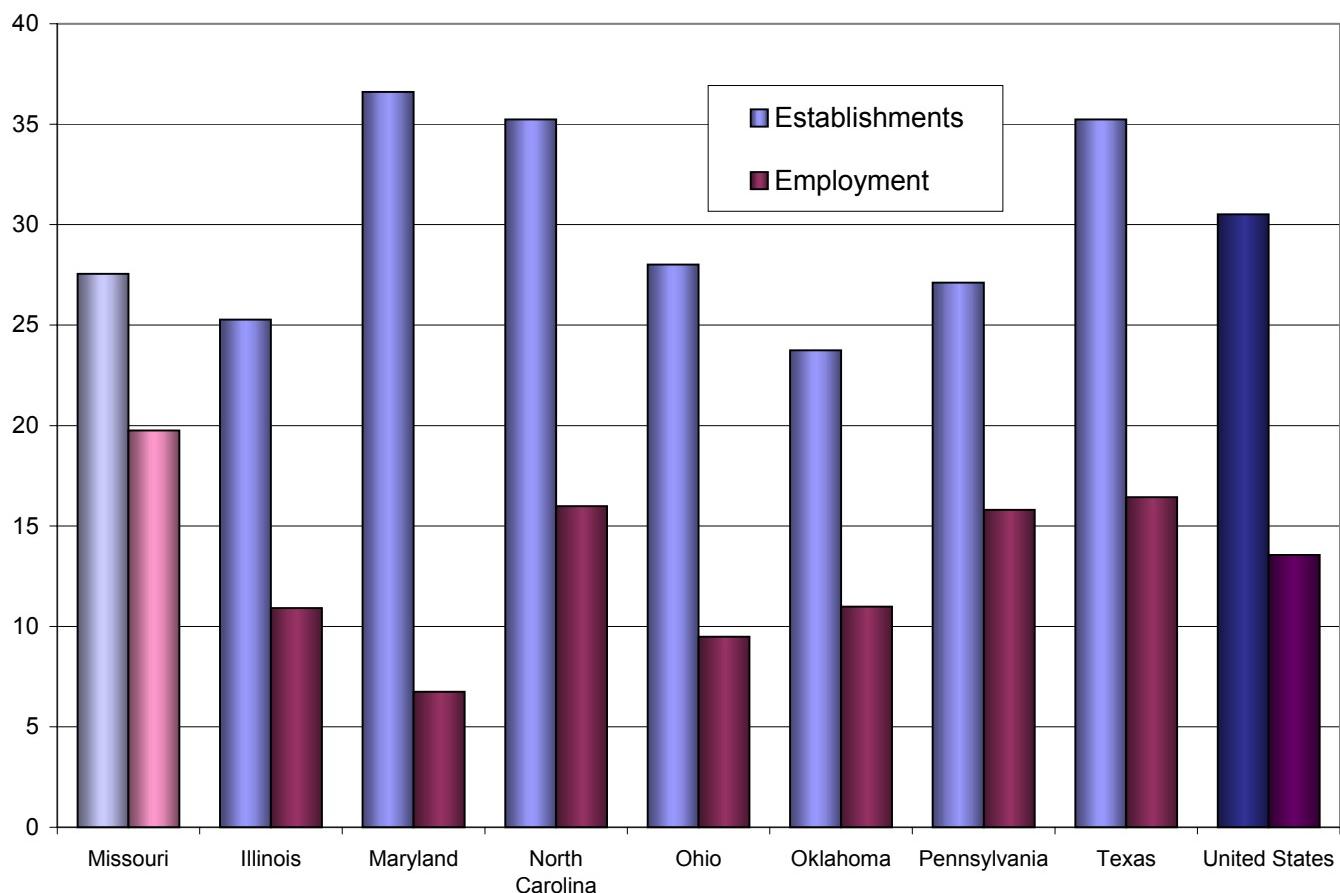
The fact that **only 11 percent of research and testing employment is found in establishments five or fewer years old** may be of more concern, since this subsector is one of the most dynamic industry segments on the national scale, producing and developing many of the most innovative and successful high-technology ideas. Indeed, 22 percent of U.S. research and testing employment is contained within youthful firms, and several benchmark states report levels nearer to 30 percent (see Figure 17).²³ About 30 percent of Missouri's research and testing establishments were formed recently, somewhat lower than the fraction reported for most of the benchmark states and the nation as a whole. An active entrepreneurial presence is indicated within the Missouri subsector, though not quite reaching the national standard, as is a substantial amount of turnover and "churn"; but, successes leading to employment growth have been limited at least of late.

Establishments that exert sole or primary control over their regional operations compose nearly 70 percent of the Missouri life science sector and also employ some 70 percent of the life science workers in the region. As might be expected given the

²³ Within the life science research and testing subsector only, the figures for the United States and the benchmark states report percentages based upon the entire set of establishments contained within the range of SIC classifications in the subsector's definition, including those partially included for Missouri. In other words, SIC classifications only partially included for Missouri are fully included for the United States and the benchmark states for the sole purpose of calculating the fraction of establishments formed five or fewer years ago and the fraction of subsectoral employment contained therein. Thus, because it is impossible to distinguish life science from non-life-science establishments in the absence of local information, the calculations necessarily assume a similar youthfulness ratio among the non-life-science establishments included.

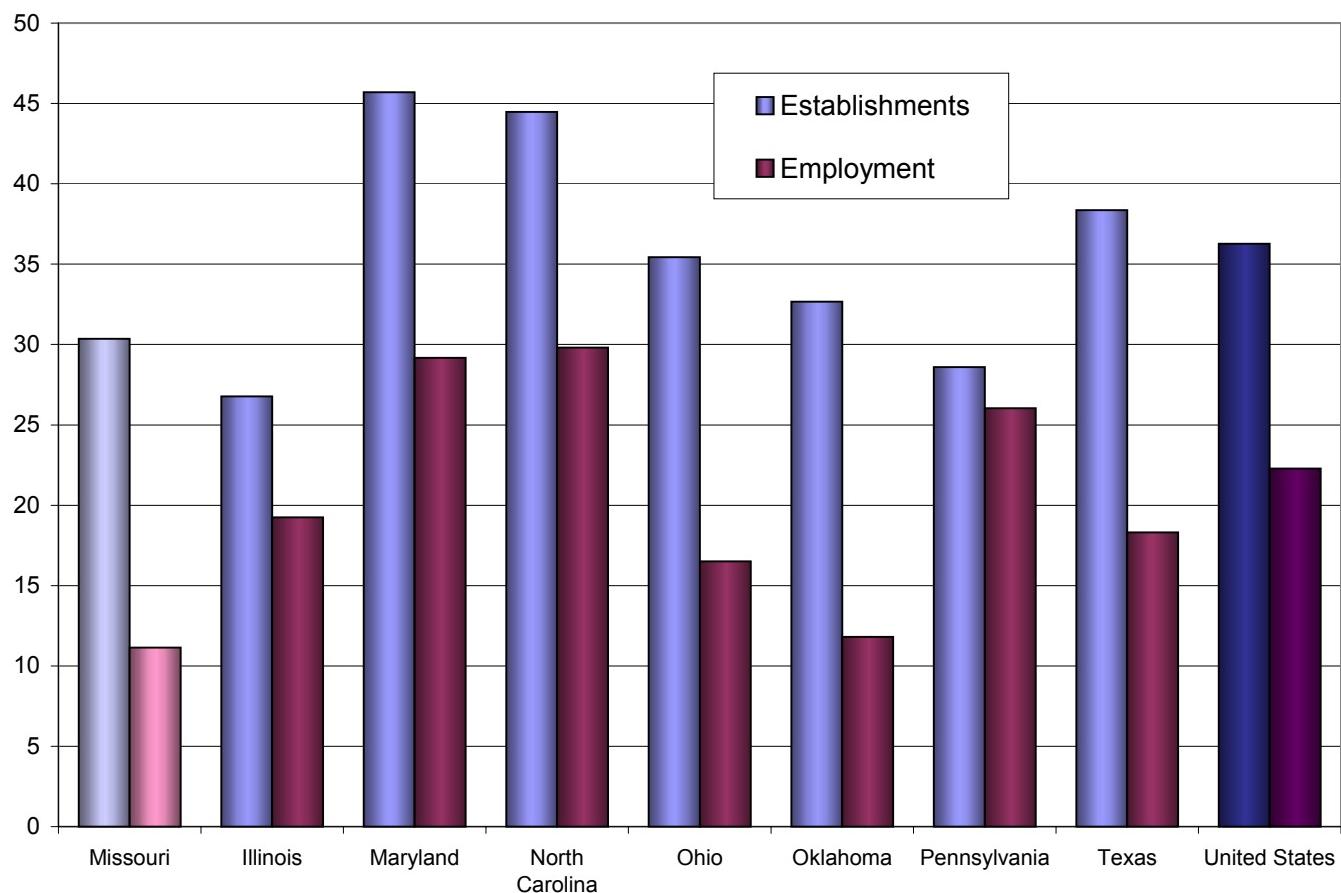
diversity of endeavor contained within the life sciences, the majority of establishments are individual sites. Only 11.5 percent of Missouri's life science establishments are classified as subsidiary or non-subsidiary headquarters, yet these sites account for nearly half of Missouri's life science employment. Non-subsidiary headquarters establishments are particularly prevalent within the hospitals and laboratories subsector, whereas subsidiary headquarters employ large percentages of the workforce in the drugs and pharmaceuticals and in the medical devices and instruments subsectors—both subsectors containing several establishments that are part of multinational firms. Branch sites account for much of the employment contained in several subsectors, including food and nutrition, organic and agricultural chemicals, and drugs and pharmaceuticals. A **surprisingly large amount of research and testing employment—67 percent—is contained within branch sites**, another issue worthy of trepidation: the subsector may lack the local control necessary to guide development in a fashion responsive to local and regional conditions and concerns.²⁴

Figure 16. Youthful Life Science Establishments and Employment in Missouri, Benchmark States, and the United States (2001)



²⁴ The location of the headquarters corresponding to individual branch establishments cannot be determined through the *MarketPlace* survey.

Figure 17. Youthful Research & Testing Establishments and Employment in Missouri, Benchmark States, and the United States (2001)



CONCLUSIONS

The life science sector in Missouri is a vital and expanding part of the regional economy. Hospitals and laboratories constitute the lion's share of life science employment in Missouri and have exhibited strong growth. Beyond hospitals and laboratories, however, the economic performance of the Missouri life science sector has left much to be desired, actually declining in employment in recent years. Traditional manufacturing industries constitute the bulk of Missouri's base in the non-clinical life sciences, with a substantial specialization in food and nutrition and a smaller concentration in organic and agricultural chemicals, as well as significant though declining bases in drugs and pharmaceuticals and medical device and instrument manufacturing. If the frequency of consolidations and downsizings ebbs, these four subsectors can provide a solid foundation upon which the entire life science sector can continue to build and advance.

Relative underconcentration of employment and modest employment growth in comparison with the rest of the nation, however, indicate a vital lack of dynamism in the high-technology research and testing subsector. Although rapid establishment formation demonstrates a degree of entrepreneurialism, the dearth of expanding youthful firms and the concentration of employment within branch sites exercising relatively little local operational control do not portend well for the future in Missouri of the life science fields attracting the most attention nationally. The dispersed nature of life science activity within the major metropolitan regions of Missouri also makes it more difficult to encourage collaborative efforts and to target services and programs toward those life science endeavors most in need of support.

Neither a clear leader nor a straggler in today's life science world, Missouri is approaching a critical crossroads. The life sciences simultaneously present definite strengths along with serious deficiencies, tremendous potential accompanied by daunting risks. The path followed in the coming years will determine the prospects for the life sciences to fade away into obscurity or to shape an exciting and fruitful future in Missouri.

APPENDIX

Table A1. Missouri Metropolitan Areas by County

Metropolitan Statistical Area (MSA)	Missouri Counties	Other Counties
Columbia	Boone	
Joplin	Jasper, Newton	
Kansas City	Cass, Clay, Clinton, Jackson, Lafayette, Platte, Ray	Kansas: Johnson, Leavenworth, Miami, Wyandotte
St. Joseph	Andrew, Buchanan	
St. Louis	Franklin, Jefferson, Lincoln, St. Charles, St. Louis, Warren, St. Louis city	Illinois: Clinton, Jersey, Madison, Monroe, St. Clair
Springfield	Christian, Greene, Webster	

Data Source: United States Census Bureau.

Economic Analysis of the Life Sciences in Missouri

Table A2. Data for Detailed Life Science Industries, Missouri (1995 and 2001)

Industry	Establishments, 2001	% Ch. Establ., 95-01	Employment, 2001	% Ch. Employment, 95-01	Location Quotient, 2001	Change in L.Q., 95-01	Employees per Establ., 2001	% Empl. in 0-5 Yrs., 2001	% Empl. in HQ & indiv. sites, '01	% Ch. U.S. Establ., 1995-2001	% Ch. U.S. Empl., 1995-2001	SIC
LIFE SCIENCES TOTAL	1,815	34.8	193,117	11.0	1.14	0.10	106.4	19.8	70.4	32.4	7.3	
Food and nutrition												
Creamery butter	2	0.0	20	(9.1)	0.30	0.09	10.0	0.0	15.0	(18.2)	(31.4)	2021
Cheese, natural and processed	15	7.1	2,999	24.0	2.93	0.50	199.9	13.3	0.5	(15.1)	8.8	2022
Dry, condensed, and evaporated dairy products	12	300.0	354	(43.5)	1.11	(0.65)	29.5	15.0	11.3	109.0	(5.7)	2023
Ice cream and frozen desserts	30	87.5	762	53.3	1.24	0.42	25.4	29.2	20.9	46.2	7.1	2024
Fluid milk	16	23.1	1,354	(6.0)	1.03	(0.01)	84.6	1.9	27.8	(19.1)	0.5	2026
Prepared feeds, n.e.c.	98	(1.0)	2,810	(14.2)	2.92	(0.02)	28.7	19.5	36.2	(2.5)	(8.7)	2048
Cottonseed oil mills	1	(50.0)	25	(67.1)	0.76	(0.86)	25.0	n.a.	0.0	(4.3)	(26.0)	2074
Soybean oil mills	4	33.3	470	327.3	3.61	2.85	117.5	n.a.	0.0	13.4	(4.9)	2075
Vegetable oil mills, n.e.c.	1	n.a.	10	n.a.	0.23	0.23	10.0	n.a.	0.0	(14.9)	67.0	2076
Animal and marine fats and oils	11	10.0	171	(10.9)	0.85	(0.28)	15.5	7.5	24.0	(7.1)	25.6	2077
Edible fats and oils	6	0.0	371	(42.9)	1.76	(0.96)	61.8	0.0	20.2	26.6	(6.7)	2079
Organic and agricultural chemicals												
Organic fibers, noncellulosic	8	33.3	1,551	(55.0)	2.16	(1.37)	193.9	89.7	82.7	14.9	(22.1)	2824
Toilet preparations	43	38.7	1,521	5.4	0.51	0.07	35.4	9.5	47.8	28.8	(3.4)	2844
Industrial organic chemicals, n.e.c.	25	(13.8)	1,579	1.3	0.61	0.03	63.2	53.3	28.1	9.2	1.3	2869
Agricultural chemicals, non-fertilizer	38	35.7	3,220	142.8	3.88	1.98	84.7	15.9	42.7	27.1	25.7	2879
additional life science establishments	2	0.0	25	0.0	n.a.	n.a.	12.5	n.a.	0.0	n.a.	n.a.	5191*
Drugs and pharmaceuticals												
Medicinals and botanicals	16	14.3	151	(93.8)	0.15	(3.37)	9.4	15.5	47.0	54.6	50.6	2833
Pharmaceutical preparations	104	33.3	7,698	(15.5)	0.87	(0.46)	74.0	15.0	37.1	70.4	36.0	2834
Diagnostic substances	3	(40.0)	162	(3.6)	0.28	(0.13)	54.0	0.0	0.6	56.0	49.5	2835
Biological products except diagnostic	33	50.0	2,432	(17.8)	4.09	(3.47)	73.7	32.6	72.1	35.8	60.5	2836
Medical devices and instruments												
Pharmaceutical machinery	3	0.0	328	182.8	6.08	5.23	109.3	0.0	100.0	17.8	(58.2)	3559-9922
Laboratory apparatus and furniture	18	63.6	239	(32.7)	0.47	(0.22)	13.3	7.4	96.2	11.7	5.1	3821
Analytical instruments	27	80.0	186	66.1	0.16	0.05	6.9	41.7	76.3	42.5	16.5	3826
Surgical and medical instruments	88	12.8	4,537	(3.4)	1.04	(0.08)	51.6	42.3	58.4	14.4	9.8	3841
Surgical appliances and supplies	78	8.3	1,335	(9.1)	0.45	(0.11)	17.1	24.2	84.7	15.0	18.5	3842
X-ray apparatus and tubes	2	0.0	28	(95.4)	0.10	(1.41)	14.0	0.0	85.7	14.4	(23.7)	3844
Electromedical equipment	14	75.0	814	(8.5)	0.69	(0.31)	58.1	19.5	82.2	35.9	40.4	3845
additional life science establishments	2	0.0	565	32.6	n.a.	n.a.	282.5	0.0	29.2	n.a.	n.a.	2822, 3089-9913*
Hospitals and laboratories												
General medical and surgical hospitals	314	13.4	130,594	11.0	1.17	0.16	415.9	19.6	78.5	13.0	0.9	8062
Specialty hospitals except psychiatric	272	56.3	13,306	80.6	1.68	0.64	48.9	2.0	88.0	40.4	18.7	8069
Medical laboratories	339	63.8	6,882	73.9	1.09	0.15	20.3	42.0	61.7	43.0	59.0	8071
additional life science establishments	1	n.a.	700	n.a.	n.a.	n.a.	700.0	n.a.	0.0	n.a.	n.a.	7363-9905*
Research and testing												
Commercial physical research, n.e.c.	15	15.4	2,589	(0.7)	0.76	(0.40)	172.6	9.1	1.8	21.3	60.6	8731-0000†
Biological research	36	9.1	772	38.4	0.47	(0.05)	21.4	21.4	49.4	62.2	62.0	8731-01
Commercial research laboratories	5	150.0	287	355.6	0.49	0.37	57.4	2.4	71.4	96.0	20.5	8731-0202†
Medical research commercial	16	220.0	130	94.0	0.23	(0.03)	8.1	15.4	96.2	85.3	134.6	8731-9902
Commercial non-laboratory research services	10	100.0	555	1,690.3	1.25	0.96	55.5	6.5	8.3	109.0	331.1	8732-0108†
Noncommercial biological research organization	43	168.8	467	226.6	0.28	0.19	10.9	20.0	73.4	76.8	12.0	8733-01
Noncommercial research institutes	8	166.7	144	27.4	0.15	0.06	18.0	0.0	34.0	122.0	(25.1)	8733-9902†
Scientific research agencies	4	n.a.	10	n.a.	0.15	n.a.	2.5	62.5	80.0	n.a.	n.a.	8733-9904†
Testing laboratories	41	57.7	422	(10.8)	0.64	(0.12)	10.3	10.4	77.5	72.3	11.4	8734-0000†
Food testing service	3	0.0	18	5.9	0.20	(0.26)	6.0	n.a.	16.7	7.9	158.0	8734-9903
Seed testing laboratory	2	0.0	5	0.0	0.29	0.00	2.5	0.0	100.0	(4.7)	5.0	8734-9908
Veterinary testing	3	0.0	16	6.7	0.92	0.06	5.3	0.0	100.0	45.1	(17.4)	8734-9910
additional life science establishments	3	0.0	503	(9.0)	n.a.	n.a.	167.7	0.0	80.1	n.a.	n.a.	8732-0000, 8734-0203*

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Note: n.a. = not applicable, n.e.c. = not elsewhere classified.

* Additional establishments taken from non-life-science SIC categories.

† SIC category partially included, see footnote 5.

Economic Analysis of the Life Sciences in Missouri

Table A3. Data for Detailed Life Science Industries, St. Louis (1995 and 2001)

Industry	Establishments, 2001	% Ch. Estab., '95-'01	Employment, 2001	% Ch. Employment, '95-'01	Location Quotient, 2001	Change in L.Q., '95-'01	Employees per Estab., 2001	% Empl. in 0-5 Yrs., 2001	% Empl. in HQ & indir. sites, '01	% Ch. U.S. Estab., 1995-2001	% Ch. U.S. Empl., 1995-2001	SIC
LIFE SCIENCES TOTAL	737	38.3	74,211	(12.9)	1.12	(0.09)	100.7	18.1	62.6	32.4	7.3	
Food and nutrition												
Creamery butter	1	0.0	17	(15.0)	0.65	0.19	17.0	n.a.	0.0	(18.2)	(31.4)	2021
Cheese, natural and processed	5	25.0	181	n.a.	0.45	0.45	36.2	0.0	3.9	(15.1)	8.8	2022
Dry, condensed, and evaporated dairy products	4	100.0	272	(56.1)	2.18	(1.95)	68.0	4.5	8.1	109.0	(5.7)	2023
Ice cream and frozen desserts	18	80.0	235	10.8	0.98	0.15	13.1	56.0	32.3	46.2	7.1	2024
Fluid milk	6	20.0	417	5.3	0.81	0.13	69.5	0.0	1.4	(19.1)	0.5	2026
Prepared feeds, n.e.c.	16	(15.8)	650	(36.2)	1.72	(0.45)	40.6	31.0	93.7	(2.5)	(8.7)	2048
Cottonseed oil mills	0	(100.0)	0	(100.0)	0.00	(0.20)	n.a.	n.a.	n.a.	(4.3)	(26.0)	2074
Soybean oil mills	1	0.0	300	n.a.	5.88	5.88	300.0	n.a.	0.0	13.4	(4.9)	2075
Vegetable oil mills, n.e.c.	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	(14.9)	67.0	2076
Animal and marine fats and oils	3	0.0	67	0.0	0.85	(0.09)	22.3	0.0	37.3	(7.1)	25.6	2077
Edible fats and oils	2	(33.3)	70	(41.7)	0.84	(0.35)	35.0	0.0	57.1	26.6	(6.7)	2079
Organic and agricultural chemicals												
Organic fibers, noncellulosic	6	50.0	1,315	(60.5)	4.67	(3.44)	219.2	99.5	87.9	14.9	(22.1)	2824
Toilet preparations	19	(5.0)	819	4.7	0.70	0.13	43.1	2.6	76.4	28.8	(3.4)	2844
Industrial organic chemicals, n.e.c.	15	(21.1)	1,133	(9.9)	1.11	0.01	75.5	14.3	9.9	9.2	1.3	2869
Agricultural chemicals, non-fertilizer	18	28.6	1,780	84.3	5.47	2.18	98.9	1.4	53.0	27.1	25.7	2879
additional life science establishments	0	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5191*
Drugs and pharmaceuticals												
Medicinals and botanicals	5	(28.6)	109	(95.4)	0.28	(8.00)	21.8	3.4	26.6	54.6	50.6	2833
Pharmaceutical preparations	49	40.0	4,447	29.1	1.29	0.09	90.8	11.5	50.7	70.4	36.0	2834
Diagnostic substances	2	(33.3)	161	(1.8)	0.72	(0.25)	80.5	0.0	0.6	56.0	49.5	2835
Biological products except diagnostic	12	50.0	787	(53.0)	3.38	(6.78)	65.6	0.3	74.6	35.8	60.5	2836
Medical devices and instruments												
Pharmaceutical machinery	2	0.0	128	16.4	6.05	4.14	64.0	0.0	100.0	17.8	(58.2)	3559-9922
Laboratory apparatus and furniture	8	100.0	30	130.8	0.15	0.09	3.8	43.3	100.0	11.7	5.1	3821
Analytical instruments	12	71.4	46	170.6	0.10	0.06	3.8	25.6	89.1	42.5	16.5	3826
Surgical and medical instruments	50	4.2	3,362	(6.2)	1.96	(0.06)	67.2	45.9	68.4	14.4	9.8	3841
Surgical appliances and supplies	35	25.0	492	(44.1)	0.43	(0.37)	14.1	44.9	91.3	15.0	18.5	3842
X-ray apparatus and tubes	0	(100.0)	0	(100.0)	0.00	(3.57)	n.a.	n.a.	n.a.	14.4	(23.7)	3844
Electromedical equipment	7	133.3	667	(11.7)	1.43	(0.57)	95.3	19.9	97.0	35.9	40.4	3845
additional life science establishments	1	0.0	165	534.6	n.a.	n.a.	165.0	0.0	100.0	n.a.	n.a.	2822, 3089-9913*
Hospitals and laboratories												
General medical and surgical hospitals	103	13.2	45,482	(15.9)	1.04	(0.06)	441.6	13.4	68.8	13.0	0.9	8062
Specialty hospitals except psychiatric	96	50.0	3,330	(26.7)	1.07	(0.46)	34.7	1.8	82.0	40.4	18.7	8069
Medical laboratories	147	83.8	3,187	229.2	1.29	0.74	21.7	66.3	43.0	43.0	59.0	8071
additional life science establishments	1	n.a.	700	n.a.	n.a.	n.a.	700.0	n.a.	0.0	n.a.	n.a.	7363-9905*
Research and testing												
Commercial physical research, n.e.c.	8	14.3	2,541	(1.7)	1.90	(0.83)	317.6	37.5	0.4	21.3	60.6	8731-0000†
Biological research	13	44.4	507	315.6	0.78	0.51	39.0	23.2	52.7	62.2	62.0	8731-01
Commercial research laboratories	1	n.a.	5	n.a.	0.02	0.02	5.0	100.0	100.0	96.0	20.5	8731-0202†
Medical research commercial	13	225.0	119	91.9	0.54	(0.04)	9.2	7.1	95.8	85.3	134.6	8731-9902
Commercial non-laboratory research services	6	200.0	40	400.0	0.23	0.06	6.7	9.4	80.0	109.0	331.1	8732-0108†
Noncommercial biological research organization	18	260.0	145	559.1	0.22	0.19	8.1	48.0	86.2	76.8	12.0	8733-01
Noncommercial research institutes	4	300.0	82	9.3	0.21	0.08	20.5	0.0	3.7	122.0	(25.1)	8733-9902†
Scientific research agencies	3	n.a.	8	n.a.	0.31	n.a.	2.7	50.0	75.0	n.a.	n.a.	8733-9904†
Testing laboratories	26	85.7	315	126.6	1.21	0.69	12.1	13.5	77.5	72.3	11.4	8734-0000†
Food testing service	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	7.9	158.0	8734-9903
Seed testing laboratory	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	(4.7)	5.0	8734-9908
Veterinary testing	0	(100.0)	0	(100.0)	0.00	(0.14)	n.a.	n.a.	n.a.	45.1	(17.4)	8734-9910
additional life science establishments	1	0.0	100	0.0	n.a.	n.a.	100.0	n.a.	0.0	n.a.	n.a.	8732-0000, 8734-0203*

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Note: n.a. = not applicable, n.e.c. = not elsewhere classified.

* Additional establishments taken from non-life-science SIC categories.

† SIC category partially included, see footnote 5.

Table A4. Data for Detailed Life Science Industries, Kansas City (1995 and 2001)

Industry	Establishments, 2001	% Ch. Estab., 95-01	Employment, 2001	% Ch. Employment, 95-01	Location Quotient, 2001	Change in L.Q., 95-01	Employees per Estab., 2001	% Empl. in 0-5 Yrs., 2001	% Empl. in HQ & indir. sites, '01	% Ch. U.S. Estab., 1995-2001	% Ch. U.S. Empl., 1995-2001	SIC
LIFE SCIENCES TOTAL	496	37.0	50,290	27.1	1.00	0.15	101.4	9.5	71.2	32.4	7.3	
Food and nutrition												
Food and nutrition	40	21.2	1,156	0.2	0.79	(0.01)	28.9	2.6	13.8	6.4	0.3	
Organic and agricultural chemicals	33	73.7	864	257.0	0.41	0.29	26.2	53.2	41.3	22.1	(1.5)	
Drugs and pharmaceuticals	58	34.9	2,928	(48.0)	0.90	(1.52)	50.5	71.1	35.6	62.5	39.0	
Medical devices and instruments	72	28.6	1,591	36.0	0.51	0.08	22.1	10.6	86.0	18.9	13.1	
Hospitals and laboratories	245	31.7	42,301	38.8	1.13	0.28	172.7	7.1	76.0	30.8	3.8	
Research and testing	48	92.0	1,450	58.0	0.48	0.06	30.2	3.1	50.6	73.7	36.2	
Organic and agricultural chemicals												
Organic fibers, noncellulosic	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	(18.2)	(31.4)	2824
Toilet preparations	15	66.7	49	6.5	0.06	0.00	3.3	33.3	98.0	28.8	(3.4)	2844
Industrial organic chemicals, n.e.c.	5	66.7	172	1,046.7	0.22	0.20	34.4	95.3	100.0	9.2	1.3	2869
Agricultural chemicals, non-fertilizer	12	100.0	638	262.5	2.59	1.68	53.2	7.3	21.5	27.1	25.7	2879
additional life science establishments	1	0.0	5	0.0	n.a.	n.a.	5.0	n.a.	0.0	n.a.	n.a.	5191*
Drugs and pharmaceuticals												
Medicinals and botanicals	6	100.0	26	73.3	0.09	0.01	4.3	38.5	100.0	54.6	50.6	2833
Pharmaceutical preparations	38	22.6	1,772	(61.9)	0.68	(1.75)	46.6	43.6	20.6	70.4	36.0	2834
Diagnostic substances	1	(50.0)	1	(75.0)	0.01	(0.03)	1.0	n.a.	0.0	56.0	49.5	2835
Biological products except diagnostic	13	85.7	1,129	17.2	6.39	(2.41)	86.8	87.1	57.8	35.8	60.5	2836
Medical devices and instruments												
Pharmaceutical machinery	1	0.0	200	3,233.3	12.47	12.31	200.0	0.0	100.0	17.8	(58.2)	3559-9922
Laboratory apparatus and furniture	7	16.7	203	(40.6)	1.35	(1.05)	29.0	0.0	95.6	11.7	5.1	3821
Analytical instruments	10	100.0	100	92.3	0.29	0.11	10.0	49.5	98.0	42.5	16.5	3826
Surgical and medical instruments	24	41.2	248	22.2	0.19	0.02	10.3	24.4	90.7	14.4	9.8	3841
Surgical appliances and supplies	23	4.5	673	55.8	0.77	0.18	29.3	6.7	90.5	15.0	18.5	3842
X-ray apparatus and tubes	1	n.a.	24	n.a.	0.28	0.28	24.0	0.0	100.0	14.4	(23.7)	3844
Electromedical equipment	6	20.0	143	5.9	0.41	(0.14)	23.8	7.1	12.6	35.9	40.4	3845
additional life science establishments	0	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2822, 3089-9913*
Hospitals and laboratories												
General medical and surgical hospitals	62	(6.1)	36,491	41.0	1.10	0.31	588.6	5.4	75.0	13.0	0.9	8062
Specialty hospitals except psychiatric	93	66.1	2,784	28.4	1.18	0.08	29.9	2.1	87.1	40.4	18.7	8069
Medical laboratories	90	40.6	3,026	25.5	1.61	(0.44)	33.6	33.1	78.2	43.0	59.0	8071
additional life science establishments	0	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7363-9905*
Research and testing												
Commercial physical research, n.e.c.	6	100.0	44	175.0	0.04	0.02	7.3	0.0	72.7	21.3	60.6	8731-0000†
Biological research	9	(10.0)	62	(75.3)	0.13	(0.70)	6.9	44.4	56.5	62.2	62.0	8731-01
Commercial research laboratories	3	50.0	82	30.2	0.47	0.03	27.3	n.a.	0.0	96.0	20.5	8731-0202†
Medical research commercial	2	100.0	8	60.0	0.05	(0.02)	4.0	100.0	100.0	85.3	134.6	8731-9902
Commercial non-laboratory research services	1	n.a.	500	n.a.	3.78	3.78	500.0	n.a.	0.0	109.0	331.1	8732-0108†
Noncommercial biological research organization	19	533.3	282	1,662.5	0.57	0.53	14.8	3.8	68.1	76.8	12.0	8733-01
Noncommercial research institutes	1	n.a.	6	n.a.	0.02	0.02	6.0	n.a.	0.0	122.0	(25.1)	8733-9902†
Scientific research agencies	1	n.a.	2	n.a.	0.10	n.a.	2.0	100.0	100.0	n.a.	n.a.	8733-9904†
Testing laboratories	2	0.0	58	(45.8)	0.29	(0.31)	29.0	0.0	100.0	72.3	11.4	8734-0000†
Food testing service	1	0.0	3	0.0	0.11	(0.18)	3.0	n.a.	100.0	7.9	158.0	8734-9903
Seed testing laboratory	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	(4.7)	5.0	8734-9908
Veterinary testing	1	0.0	0	(100.0)	0.00	(0.82)	0.0	n.a.	n.a.	45.1	(17.4)	8734-9910
additional life science establishments	2	0.0	403	(11.0)	n.a.	n.a.	201.5	0.0	100.0	n.a.	n.a.	8732-0000, 8734-0203*

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Note: n.a. = not applicable, n.e.c. = not elsewhere classified.

* Additional establishments taken from non-life-science SIC categories.

† SIC category partially included, see footnote 5.

Table A5. Data for Detailed Life Science Industries, Missouri, excluding St. Louis and Kansas City (1995 and 2001)

Industry	Establishments, 2001	% Ch. Estab., 95-01	Employment, 2001	% Ch. Employment, 95-01	Location Quotient, 2001	Change in L.Q., 95-01	Employees per Estab., 2001	% Emplo. in 0-5 Yrs., 2001	% Emplo. in HQ & indiv. sites, '01	% Ch. U.S. Estab., 1995-2001	% Ch. U.S. Emplo., 1995-2001	SIC
LIFE SCIENCES TOTAL	582	29.0	68,616	39.3	1.30	0.32	117.9	16.6	78.3	32.4	7.3	
Food and nutrition	100	16.3	5,981	5.0	3.92	0.25	59.8	3.1	13.1	6.4	0.3	
Organic and agricultural chemicals	25	25.0	1,985	62.8	0.90	0.36	79.4	45.7	31.9	22.1	(1.5)	
Drugs and pharmaceuticals	30	30.4	2,011	49.4	0.59	0.05	67.0	1.8	38.0	62.5	39.0	
Medical devices and instruments	45	12.5	1,551	2.7	0.47	(0.04)	34.5	20.2	13.7	18.9	13.1	
Hospitals and laboratories	334	40.9	56,482	45.3	1.45	0.43	169.1	16.8	90.1	30.8	3.8	
Research and testing	48	6.7	606	(1.3)	0.19	(0.07)	12.6	3.2	69.0	73.7	36.2	
Food and nutrition												
Creamery butter	1	0.0	3	50.0	0.14	0.08	3.0	0.0	100.0	(18.2)	(31.4)	2021
Cheese, natural and processed	9	(10.0)	2,758	14.0	8.67	0.56	306.4	25.0	0.3	(15.1)	8.8	2022
Dry, condensed, and evaporated dairy products	3	n.a.	66	n.a.	0.67	0.67	22.0	100.0	3.0	109.0	(5.7)	2023
Ice cream and frozen desserts	7	75.0	435	106.2	2.28	1.12	62.1	33.3	2.3	46.2	7.1	2024
Fluid milk	7	0.0	843	(15.8)	2.07	(0.35)	120.4	2.2	38.1	(19.1)	0.5	2026
Prepared feeds, n.e.c.	64	12.3	1,660	(8.7)	5.56	0.11	25.9	1.8	23.4	(2.5)	(8.7)	2048
Cottonseed oil mills	1	0.0	25	(65.3)	2.45	(2.67)	25.0	n.a.	0.0	(4.3)	(26.0)	2074
Soybean oil mills	1	0.0	50	0.0	1.24	0.08	50.0	n.a.	0.0	13.4	(4.9)	2075
Vegetable oil mills, n.e.c.	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	(14.9)	67.0	2076
Animal and marine fats and oils	4	0.0	20	(78.0)	0.32	(1.48)	5.0	20.0	75.0	(7.1)	25.6	2077
Edible fats and oils	3	200.0	121	303.3	1.84	1.43	40.3	0.0	28.9	26.6	(6.7)	2079
Organic and agricultural chemicals												
Organic fibers, noncellulosic	2	0.0	236	105.2	1.06	0.66	118.0	0.0	53.4	14.9	(22.1)	2824
Toilet preparations	9	350.0	653	6.2	0.70	0.08	72.6	69.8	8.1	28.8	(3.4)	2844
Industrial organic chemicals, n.e.c.	5	(28.6)	274	(3.9)	0.34	(0.01)	54.8	35.2	58.0	9.2	1.3	2869
Agricultural chemicals, non-fertilizer	8	0.0	802	335.9	3.11	2.23	100.3	66.4	36.8	27.1	25.7	2879
additional life science establishments	1	0.0	20	0.0	n.a.	n.a.	20.0	n.a.	0.0	n.a.	n.a.	5191*
Drugs and pharmaceuticals												
Medicinals and botanicals	5	25.0	16	77.8	0.05	0.01	3.2	0.0	100.0	54.6	50.6	2833
Pharmaceutical preparations	17	41.7	1,479	45.7	0.54	0.05	87.0	6.0	15.8	70.4	36.0	2834
Diagnostic substances	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	56.0	49.5	2835
Biological products except diagnostic	8	14.3	516	60.2	2.80	0.05	64.5	0.0	99.8	35.8	60.5	2836
Medical devices and instruments												
Pharmaceutical machinery	0	n.a.	0	n.a.	0.00	0.00	n.a.	n.a.	n.a.	17.8	(58.2)	3559-9922
Laboratory apparatus and furniture	3	200.0	6	n.a.	0.04	0.04	2.0	80.0	100.0	11.7	5.1	3821
Analytical instruments	5	66.7	40	(7.0)	0.11	(0.03)	8.0	0.0	7.5	42.5	16.5	3826
Surgical and medical instruments	14	7.7	927	1.8	0.68	(0.04)	66.2	7.1	13.6	14.4	9.8	3841
Surgical appliances and supplies	20	(9.1)	170	9.0	0.19	(0.01)	8.5	41.4	42.9	15.0	18.5	3842
X-ray apparatus and tubes	1	n.a.	4	n.a.	0.04	0.04	4.0	n.a.	0.0	14.4	(23.7)	3844
Electromedical equipment	1	n.a.	4	n.a.	0.01	0.01	4.0	0.0	100.0	35.9	40.4	3845
additional life science establishments	1	0.0	400	0.0	n.a.	n.a.	400.0	n.a.	0.0	n.a.	n.a.	2822, 3089-9913*
Hospitals and laboratories												
General medical and surgical hospitals	149	24.2	48,621	29.1	1.40	0.33	326.3	18.9	90.2	13.0	0.9	8062
Specialty hospitals except psychiatric	83	53.7	7,192	1,003.1	2.92	2.61	86.7	2.1	91.2	40.4	18.7	8069
Medical laboratories	102	61.9	669	15.9	0.34	(0.12)	6.6	19.8	76.4	43.0	59.0	8071
additional life science establishments	0	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7363-9905*
Research and testing												
Commercial physical research, n.e.c.	1	(66.7)	4	(42.9)	0.00	(0.01)	4.0	0.0	100.0	21.3	60.6	8731-0000†
Biological research	14	0.0	203	9.7	0.39	(0.18)	14.5	12.2	38.9	62.2	62.0	8731-01
Commercial research laboratories	1	n.a.	200	n.a.	1.10	1.10	200.0	0.0	100.0	96.0	20.5	8731-0202†
Medical research commercial	1	n.a.	3	n.a.	0.02	0.02	3.0	100.0	100.0	85.3	134.6	8731-9902
Commercial non-laboratory research services	3	0.0	15	(34.8)	0.11	(0.59)	5.0	0.0	93.3	109.0	331.1	8732-0108†
Noncommercial biological research organization	6	(25.0)	40	(61.9)	0.08	(0.15)	6.7	0.0	65.0	76.8	12.0	8733-01
Noncommercial research institutes	3	50.0	56	47.4	0.18	0.09	18.7	0.0	82.1	122.0	(25.1)	8733-9902†
Scientific research agencies	0	n.a.	0	n.a.	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	8733-9904†
Testing laboratories	13	30.0	49	(78.4)	0.24	(0.97)	3.8	4.0	51.0	72.3	11.4	8734-0000†
Food testing service	2	0.0	15	7.1	0.53	(0.73)	7.5	#DIV/0!	0.0	7.9	158.0	8734-9903
Seed testing laboratory	2	0.0	5	0.0	0.93	(0.03)	2.5	0.0	100.0	(4.7)	5.0	8734-9908
Veterinary testing	2	100.0	16	60.0	2.96	1.06	8.0	0.0	100.0	45.1	(17.4)	8734-9910
additional life science establishments	0	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	8732-0000, 8734-0203*

Data source: Battelle calculations from Dun & Bradstreet MarketPlace survey.

Note: n.a. = not applicable, n.e.c. = not elsewhere classified.

* Additional establishments taken from non-life-science SIC categories.

† SIC category partially included, see footnote 5.